Motorship

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EXCLUSIVE technical and non-technical articles on design, construction and operation of oil-engines and motorships by the world's foremost writers on marine engineering.

Motorship

PROFUSELY illustrated with photographic reproductions of the newest designs in international merchant motorship and Diesel-engine construction and auxiliary equipment.

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Vol. IX—No. 10 New York, U. S. A., October, 1924 In Two Sections, Section I
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Another Diesel-Electric Tug Demonstrated

Atlantic Refining Company Places the VAN DYKE *in Service — a Sister to Two Preceding Boats With Similar Drive*

ONE of the applications of the Diesel-electric drive in which it shows up to particular advantage is found in the propulsion of tugboats. Further evidence of this was recently furnished by the commissioning and recent public demonstration of one of the Atlantic Refining Co.'s tugs VAN DYKE I, VAN DYKE II, and VAN DYKE III, all of which are equipped with Ingersoll-Rand oil engines and General Electric generators and propelling motors.

It was the VAN DYKE III whose demonstration in New York harbor on September 5th we were privileged to witness. Like her two sisters, she is a tug of unusual design built entirely of steel and fully capable of standing the severe usage to which steam tugs are ordinarily subjected. Built by the Staten Island Shipbuilding Company to the designs of the Atlantic Refining Company, she is particularly adapted to the economical handling of oil barges and other vessels of that general class. Principal dimensions of the VAN DYKE tugs are as as follows:

Length b. p.	87 ft. 0 in.
Length o.a.	97 ft. 0 in.
Beam	21 ft. 0 in.
Molded Depth	11 ft. 6 in.
Dead Rise	3 ft. 6 in.

In her general exterior appearance she resembles the ordinary steam tug, with the important single exception that she has no stack. Owing to the elimination of the latter and of the usual bulky steam boilers and coal bunkers, her deck structures appear shorter in proportion to the length of the hull than is the case with steam craft of this type. Nevertheless, there is so much room inside that the quarters for the crew are actually more comfortable than those of an equivalent steam tug. Needless to say, the elimination of coal and ashes makes her a considerably more attractive job for the men who operate her.

Instead of a stack there are two short funnel-ended exhaust pipes which lend a distinctive appearance to the superstructure. Cowls of the ordinary type, lifeboats, and mast such as those generally found on tugboats round out the general impression made by this craft.

Electric motive power is furnished by two three-cylinder Ingersoll-Rand four-cycle oil engines operating on the Price-Rathbun Ingersoll-Rand direct-injection system. Bore and stroke dimensions are 15 in. by 20 in. and the speed is maintained constant at 257 r.p.m. by a centrifugal governor under all conditions of maneuvering or idling of the propelling motor. A box-frame of the usual construction is used and a rigid bed-plate is bolted to stout plate-and-angle foundations riveted to the frames and plates of the hull.

The main bearings in the bedplate have square-end boxes for the lower halves and their adjustment is effected by means of the time-honored wedge and bolt, the heads of which come out through the sides of the casting. It is therefore possible, in contrast with the usual practise, to haul the upper bearing halves hard down against the bed-plate surfaces without the use of shims. As the lower half of the main bearing wears, all that is necessary to bring the clearance back to normal is a slight shift of the wedge. In contrast with the usual method of lifting the cap and changing shims this system of adjustment can be easily carried out by resetting a few screws.

But the most important consequence of the bottom-wedge adjustment is that it prevents wear-down of the lower half from affecting the combustion clearance in the cylinder. The effect of the adjustment is always to bring the level of the shaft back to its original height. It need hardly be added, also, that the arrangement reduces the possibility of getting bearings out of line as the result of setting different clearances. As has been stated, the upper bearing half, which is not subject to any appreciable wear, always gives the shaft journals the same fixed position. Since the same principle has

Diesel-electric tug "Van Dyke 3," recently completed for the Atlantic Refining Company by the Staten Island Shipbuilding Company. Replacing the stack with two exhaust funnels lends a distinctive appearance

been applied to the design of the connecting rod bearings, its length is similarly unaffected by wear and the operator has the assurance that the right cylinder clearance will be maintained as long as the bearings have the proper clearance.

Another distinctive feature of the Ingersoll-Rand engine of these boats is the elimination of cams from the timing shaft, eccentrics being used in their stead. A rolling-link mechanism incorporated in the valve housing replaces the usual rocker lever and motion is imparted to the links by rods running down to the eccentrics. Whereas this type of valve gear has been used to a considerable extent on horizontal stationary engines, its application to vertical machines possesses distinctive advantages. For one thing it permits locating the timing shaft down inside the box framing without transmitting the cam thrusts up through the valve rods. Driving the shaft can then be accomplished in a simple manner by means of gears located entirely within the housing. Vertical shafts used in connection with an overhead camshaft also allow the cams to be located near the points where the motion from them is to be applied, but they also necessitate the use of skew gears.

In the case of the engine under consideration the roller path valve motions are built right into the valve housings—as close to the valve spindles as it is possible to get them. Since the valve rods receive an easy harmonic motion from the eccentrics, they are not called upon to partake of the cam accelerations and the latter are applied virtually only to the parts on which they are needed. Another consequence of the arrangement is the simplification of the cylinder head arrangement, which is rendered strikingly simple because of the elimination of the fulcrum shaft and all that goes with it.

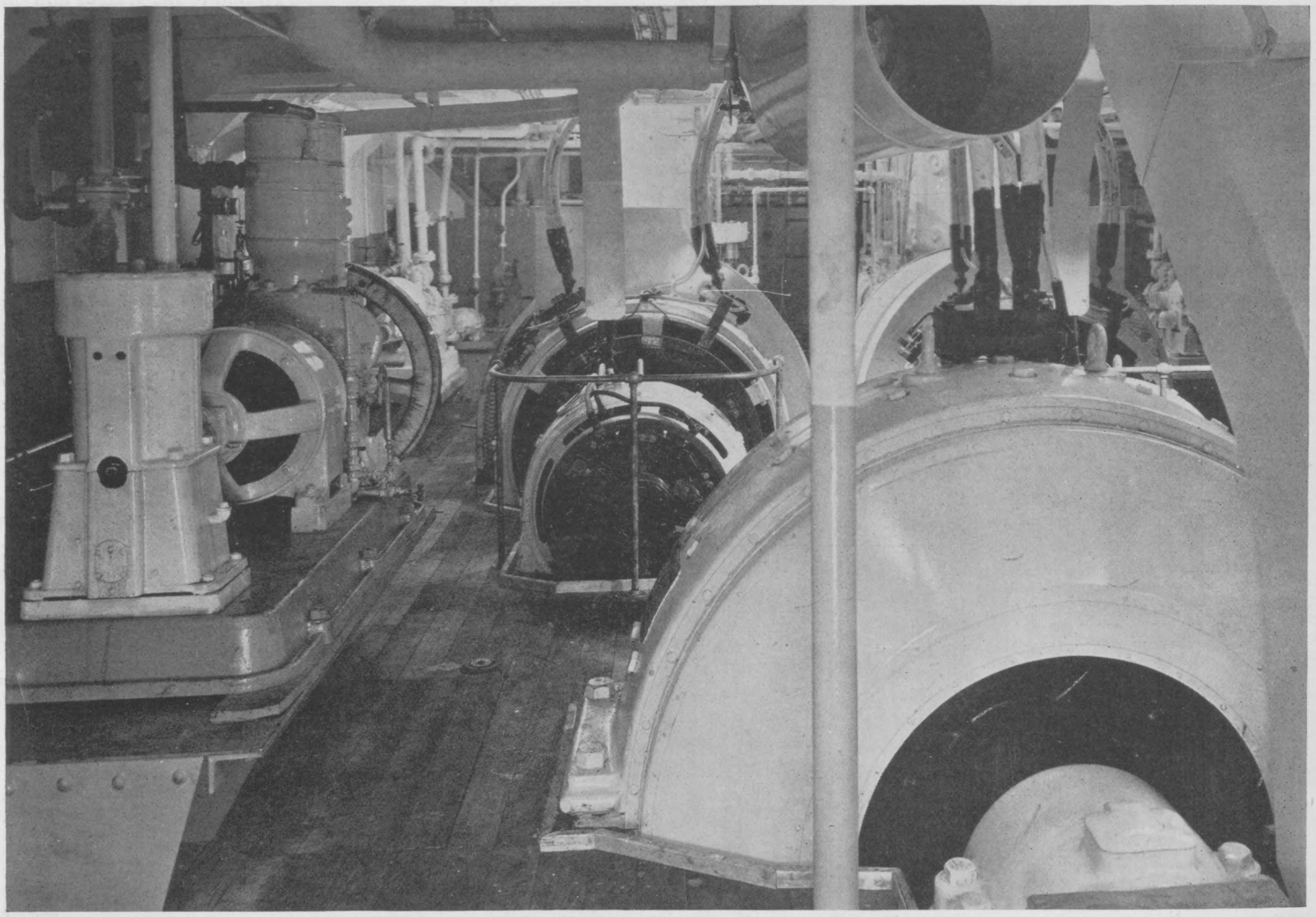
As far as the exhaust and inlet valves themselves are concerned, they are of simple construction generally resembling the usual designs. Water-cooling is provided for the cage of the exhaust valves and the protection of the valve spindle against distortion and seizing is therefore assured.

Additional protection for the exhaust valve as well as for the rest of the engine is provided in the form of a dial thermometer with a well tapped into the top of the cylinder head reaching down into the exhaust passage. Our illustration of the top of the engine, which clearly shows the valve-gear, was taken at a time when the dial thermometers had been removed and only the wells for them are visible. Making provision for them in the design of the cylinder head is a clear indication of the importance which the measurement of exhaust temperature is assuming in oil-engine operating practise.

Any diminution of the fuel supplied to an individual cylinder will at once show up on the dial as reduced temperature and any imperfection in the combustion process, such as might for instance be caused by a faulty oil spray results in afterburning and a consequent rise in the exhaust temperature. A direct check on the functioning of each cylinder, vastly more convenient than the application of an indicator, is thus available to the operator at all times.

A description of the main engine would not be complete without an account of its unique fuel pump, which consists only of a single plunger. Although such arrangements have been used in the past in connection with distributing nozzles for apportioning the supply to the individual cylinders, there has been some objection to them on the score of uneven distribution, particularly noticeable at light loads. Needless to say, single-plunger pumps with throttling distributing systems can be used only on air-injection engines in which the time of the pump delivery is of no great consequence. They have been used, also on airless-injection engines of the common-rail type and an accumulator had to be provided to take care of those cylinders which happened to be firing at the time when the pump was not delivering. In the latter case trouble sometimes resulted when a leaky fuel valve allowed the accumulator to flood the interior of the cylinder.

None of these objections have any application to the engines under consideration



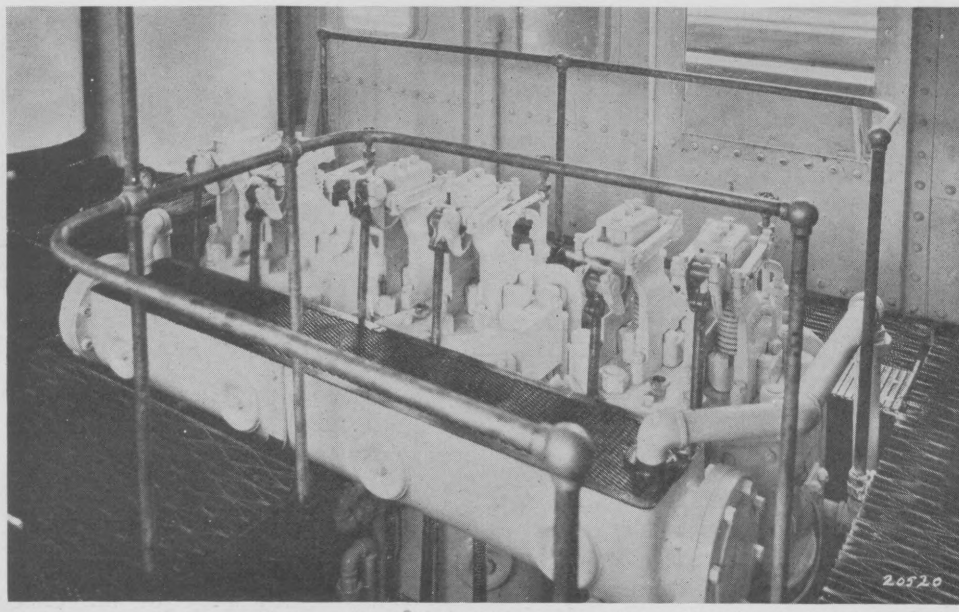
Engine-room of the "Van Dyke 3." Propelling motor in foreground, with oil-engine-driven generators and exciters behind it; standby oil-engined lighting generator and air-compressor at left

here. In contrast with the older systems the pump makes as many deliveries as there are firing strokes of the engine, which in this case number 1½ times as many as the r.p.m. or 385 per minute. A simple rotary distributor driven with an intermittent motion so that it is at rest while the oil charge passes through it, successively connects the pump to the cylinders in their proper firing order. Regulation of the load is accomplished by means of a simple by-pass valve of the needle type under the direct control of the governor.

Not only does this arrangement dispense with the complication due to the use of a multiplicity of pumps, but it appears to make unequal distribution to the various cylinders a physical impossibility. No matter what treatment the pump may have received and how seriously its delivery may have been impaired, the variations in it are bound to have the same effect on all the cylinders. Since the distributor is a relatively simple affair apparently not subject to any severe requirements either as regards speed or pressure, it appears to be a small price to pay for the elimination of the multiple pumps. Although the single plunger system as here outlined was patented in Europe, the problem of converting it into a workable design appears to have been solved by these American engineers.

Each three-cylinder oil-engine is direct-connected on the same shaft to a 155-kw. General Electric generator and a 26-kw. exciter. An adjustable outboard bearing located between the generator and exciter is provided so that correct alignment, between the armature of the generator and engine flywheel, can be maintained at all times.

Current from both generators connected in series is used for driving the General Electric propelling motor, which runs at 140 r.p.m.light and 125 r.p.m. loaded. The Ward-Leonard system of variable voltage control is employed to vary the generator voltage from zero to full rating. Both the generator and the motor fields are excited by means of current from the direct-connected exciters and whereas that part of the voltage which goes to the generator fields is varied, the excitation of the motor always has its full normal value. Since the greatest amount of field current which is necessary to make the generators produce full voltage is only a small fraction of the total current delivered by the machines, it is apparent why their full output can be so easily controlled by the small pilot-house rheostat.



Valve-gear of three-cylinder oil engine. The push-rods are eccentric-driven and the cams are built into the tops of the valve cages. Fuel and starting valves are at sides of cylinders

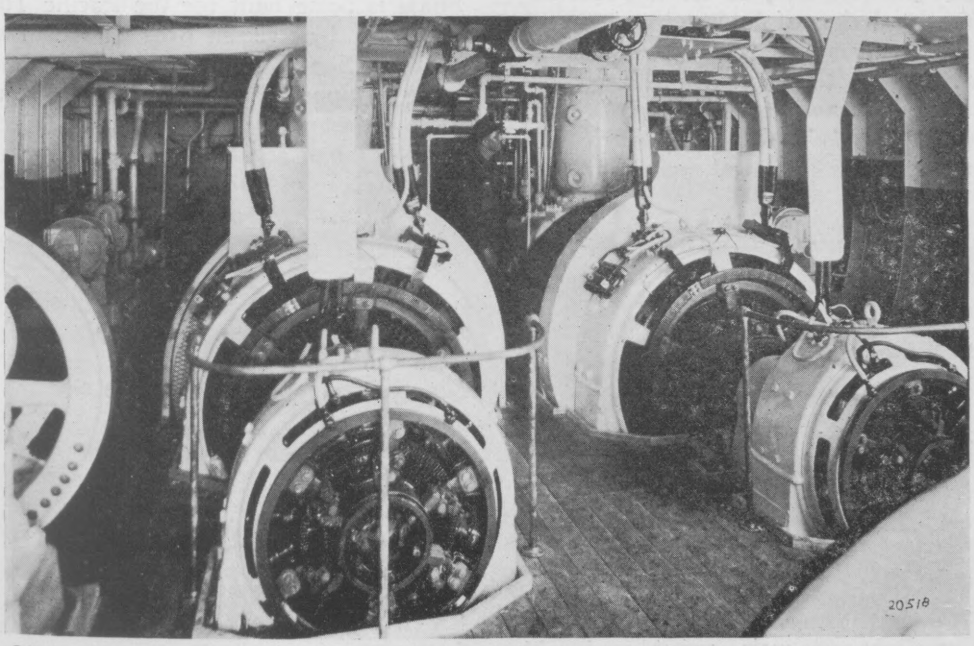
The "Van Dyke 3" under full headway

As long as the tug is clear for action the switches in the armature circuits of the generating and propelling motor remains permanently closed and the motor fields are always connected to the exciter terminals. At no time is it therefore necessary to manipulate the main line current, a circumstance which accounts for the absence of heavy controllers and rheostats characteristic of constant-voltage systems found in electric railway work. An inspection of the generator field rheostat fitted up in the Van Dyke boats shows them to be small affairs which appear quite disproportionate, from the layman's point of view, to the amount of power which they control.

Reversal, as carried out in the Ward-Leonard system, consists merely in changing the direction of the generator exciting current. This changes the polarity of the generators, the voltage impressed on the motor, and the direction of rotation of its armature. Changing from full-speed ahead to full-speed astern can probably be done more rapidly by this method than by any other and it is an amazing sight to watch the motor armature while the pilot makes a non-stop change from one direction to the other. It almost looks as though the entire rotating mass comes back on the rebound, as there is no period of stop of such duration that it can be perceived between the ahead and the astern motions.

While all this is going on the engines driving the generators keep right on going in one direction at constant speed and under the full control of the governor. As far as finding out what is going on with the boat is concerned looking at the engines is useless. All that can be detected is a rise in the readings of the exhaust pyrometers.

Auxiliaries, in the sense of independent oil-engines essential to the operation of the main units, are not found on the Van Dyke



Oil-engined electric generating equipment. The exciters (foreground) have overhung commutators

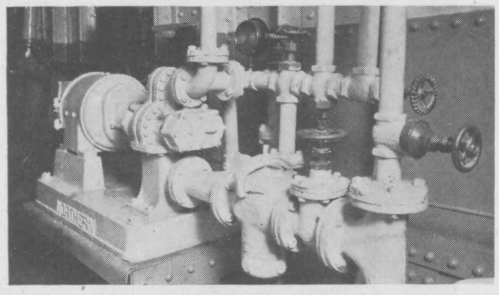
boats. Since the direct-driven exciters are of ample capacity, they can easily handle all the requirements for auxiliary power in addition to the small excitation current necessary for the main generators and the motor. In contrast with the latter, the exciters are self-excited and differ in no essential respect from an ordinary generator. They deliver current in the usual way to the steering engine, the circulating water and bilge pumps, to the auxiliary starting compressor, to the lighting system and for all the various purposes found on a ship.

Provisions are made so that a fixed excitation can be maintained on the generators. When this condition exists, power from the main generators can be fed through outlet sockets and a special switchboard to oil barges equipped with electric motor-driven cargo pumps. According to the old methods, tank barges were generally equipped with direct-acting steam pumps supplied from a steam tug by means of a flexible metallic hose. Appreciating the merits of motorized drive without reservations, the Atlantic Refining Company engineers are applying it on a considerable scale not only to their tugs, but to their barges as well. Needless to say the economics of the steam and the electric systems stand in a ratio of one to ten or more, as was pointed out in our first announcement concerning the VAN DYKE tugs.

As the result of generating the auxiliary current with the exciters instead of with separate generating sets, it becomes possible considerably to simplify the engine-room layout, a fact which was made strongly apparent also on the Diesel-electric tug P.R.R. No. 16, fully reported in MOTORSHIP for September. On both boats the roominess of the layouts and the undisturbed view which the operator has over each piece of machinery made a profound impression on the visitors who observed it.

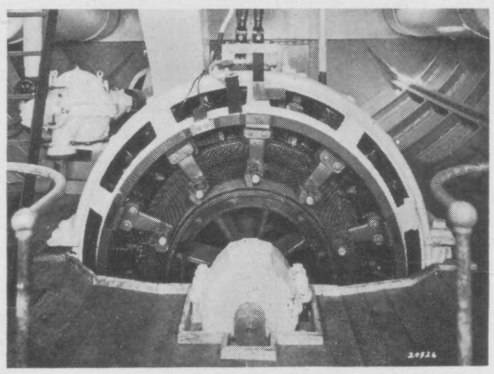
Outside of the main propelling machinery there is an Ingersoll-Rand air-compressor short belted to a General Electric motor and automatically controlled to maintain the proper pressure in the air starting tanks. To provide air before the main engines have been started up another Ingersoll-Rand air compressor is clutch-connected to a Bates & Edmonds 6-h.p. oil-engine, which also drives a 3-kw. General Electric generator. Besides being entirely self-contained and of simple construction, this oil-engined compressing and generating set possesses the great advantage of hand starting without the use of a torch, injection air, or external ignition devices. While the tug is laying to and the main engines are not running, it conveniently fills many requirements, such as for lighting current, power for the bilge pumps, and starting air.

Pumps are provided in duplicate by the Northern Fire Apparatus Company and are of the positive rotary type. Each pump contains a pair of four-lobed star shaped impellers fitted with a spring-backed packing piece and assured against side-leakage by the provision of accurately machined surfaces of large area. Since a pair of exterior spur-driving gears of normal design are provided, the impellers are re-



Motor-driven positive rotary bilge and ballast pump. Note large suction strainer

lieved of a considerable amount of mechanical strain. Ball bearings are used and are completely protected by stuffing boxes and air space from contact with the water handled by the pump. The fact that bearings of this type are practically free from wear is a further safeguard against wear and consequent leakage of the impellers. Either of the two pumps are available both for bilge and circulating work and as bilges on a tug do not require frequent pumping, the arrangement amounts virtually to the provision of a spare circu-

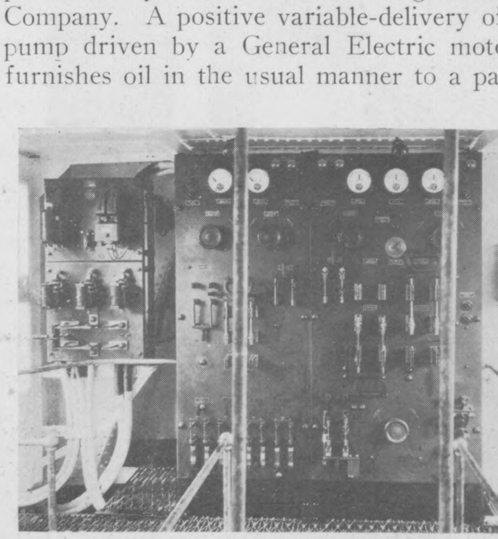


Commutator end of 375-s.h.p. propelling motor

lating pump. Strainers in the piping system for the pumps protect them and the main engine against clogging.

A Northern Fire Apparatus Company pump is also used for elevating fuel-oil from the bunkers to the daily supply tanks. A positive suction and freedom of the pumping elements from fibrous packings make them well adapted for this service.

A neat design of hydro-electric steering gear specially suited for tugboats has been provided by the American Engineering Company. A positive variable-delivery oil-pump driven by a General Electric motor furnishes oil in the usual manner to a pair



"Van Dyke 3" main switchboard with switchboard for electric pumps on barges at left

of single-acting rams. As they are pivoted direct to the rudder stock, they are also mounted on trunnions through which the oil under pressure enters and leaves. Guides are unnecessary with the oscillating arrangement and their elimination accounts for the unusually compact design which has been produced. It can be easily and spaciously accommodated in the stern of the tug—a location where the installation of the steering gear is sometimes apt to be cramped.

In the discussion of this oil engine-electric drive tug we have not been able to emphasize as strongly as is necessary the improved towing characteristics which result from the use of the electric propelling machinery. Briefly stated, the following results are obtained:

1. Engine speed never falls below 2 or 3 per cent of rated maximum, no matter what the condition of the tow may be. The governor maintains the speed of the engine and hence its power output, virtually constant.

2. The motor is such that a reduction in propeller speed caused by a heavy tow is met by an increase in motor torque, the net effect of which is to keep the propeller horsepower at its full value in spite of reduced r.p.m. and towing speed.

3. Precision in maneuvering made possible by pilot-house control is a factor in saving wear-and-tear on floating equipment.

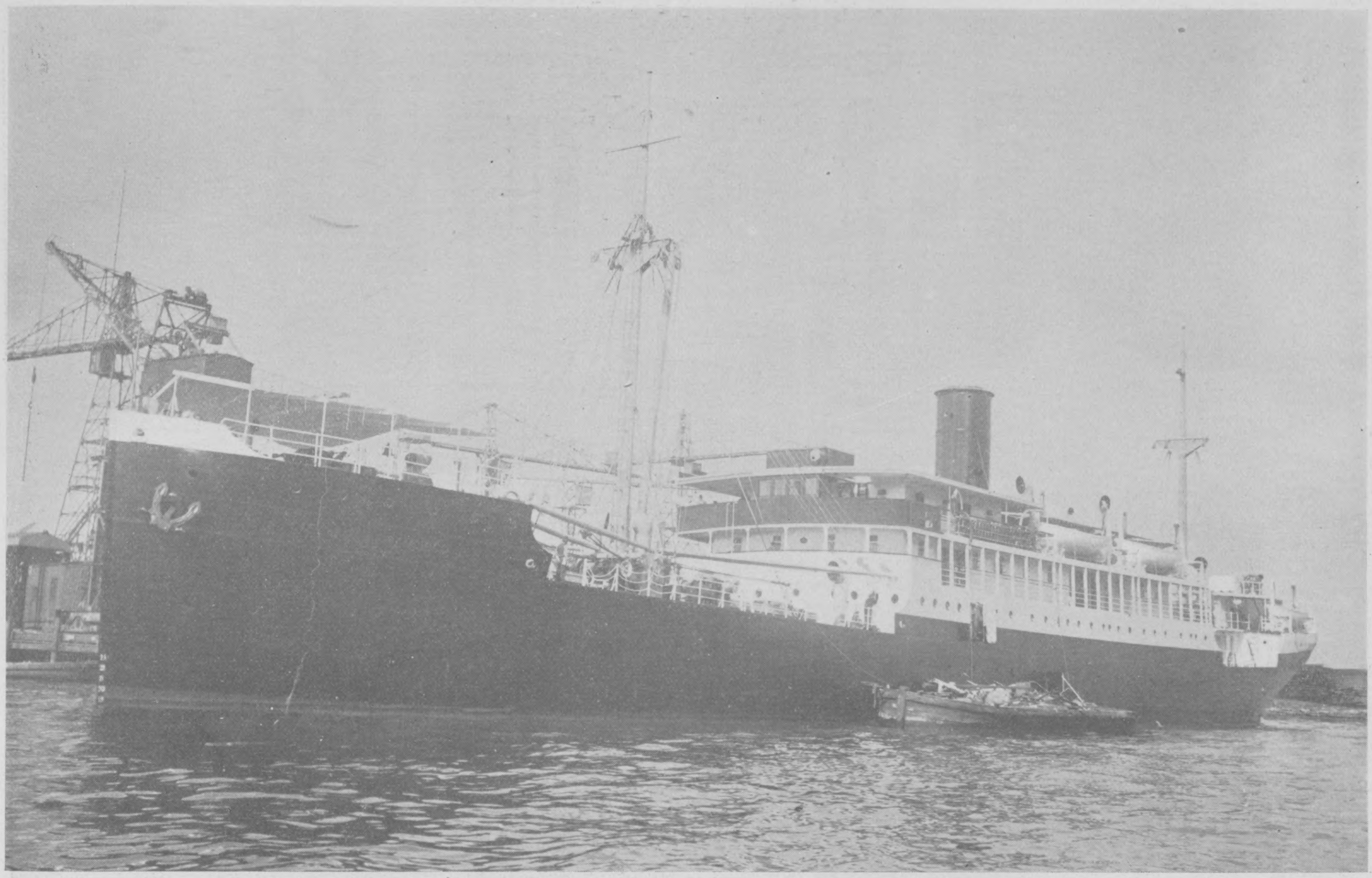
A good many characteristics of this kind have been reduced to figures and curves by the engineers concerned and although there is no particular mystery about these facts, their comparative novelty is responsible for the reticence which is shown in discussing them for publication. Many persons who are awed by the complications of the wiring on an ordinary switchboard would be surprised by the elemental simplicity of the wiring used in electric-drive layouts of the kind discussed in this article.

An oil-engined tugboat 54 ft. o.a., 14 ft. beam and 7 ft. draft, to be named PACIFIC FOAM is being built for the Pacific Tug & Barge Co. by Eriksen Bros. at North Vancouver. She is built mainly of fir, and is being equipped with a four-cylinder, two-cycle Fairbanks-Morse oil engine developing 100 b.h.p. at 340 r.p.m., and having a cylinder bore of 10½" and stroke of 12½".

Richard F. Howe of New York has ordered a 550-tons Diesel-engined yacht from Ramage & Ferguson, Leith, Scotland. This craft has been designed by Cox & King of London.

Andrew Weir & Co. have ordered four twin-screw 305-ft. Diesel driven tankers from Harland & Wolff's Belfast yard.

Diesel drive is being considered for several large liners under construction at the Montfalcone yard of the Cosulich Line.



"City of San Francisco," first of the Pacific Mail Steamship Company's new passenger-cargo motorships for their South American trade

First of Pacific Mail's Passenger-Cargo Motorships

Sea Trials of CITY OF SAN FRANCISCO, *One of Two Diesel-Driven Motorships Completed in Sweden to the Order of the Pacific Mail Steamship Company of San Francisco*

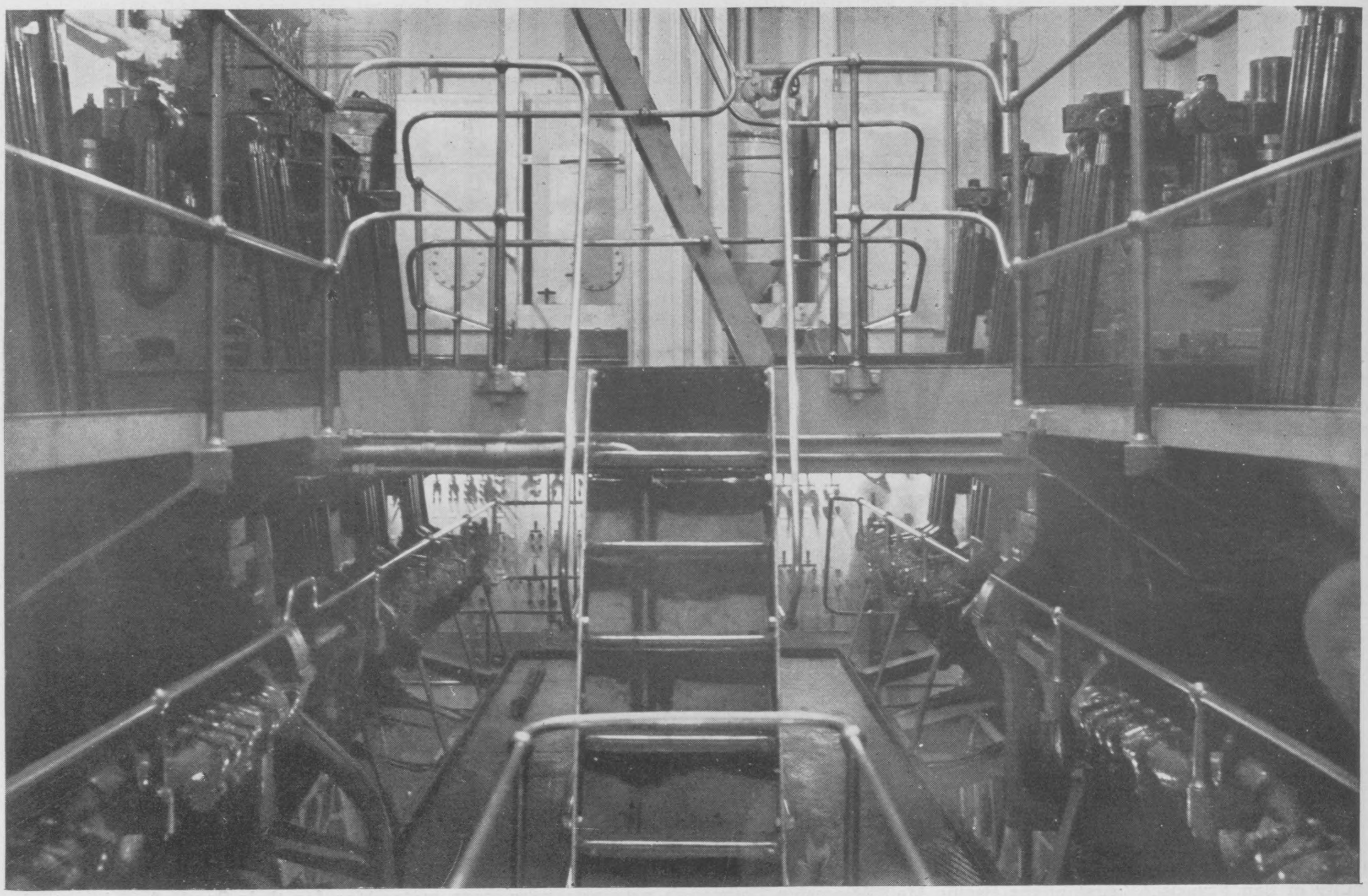
WHEN the stars and stripes as well as the flag of Panama were blowing side by side from the tall cranes at the Götaverken shipyard, Gothenburg, Sweden, on August 30th, it was obvious that some unusual event was taking place. It was the occasion of the sea trials of the first of two Diesel-driven combination passenger-cargo vessels completed at this plant for the Pacific Mail Steamship Company of San Francisco which, of course, is associated with W. R. Grace & Co., of New York. Being the first vessel to be built in Sweden for American ownership, and a motorship at that, she attracted considerable attention as she proceeded down the harbor. Aboard were a number of men prominent in the Swedish shipping and shipbuilding industries, as well as the Panama Consul, and representatives from the United States. D. Mathieson, who formerly was the superintendent-engineer of W. R. Grace & Co. in New York, surveyed the vessel in Gothenburg during construction and was present on the trials as representative of the owners.

During luncheon held on board Mr. Mathieson complimented the shipyard on its excellent workmanship. Dan Broström, the well-known Swedish shipping magnate and Chairman of the Götaverken, presided at the luncheon. Hugo D. Hammar, managing-director of the Götaverken personally conducted the guests.

The owners took over the CITY OF SAN FRANCISCO immediately following the trials and the vessel left several days later en

Smoking room

First-class dining saloon on the "City of San Francisco"

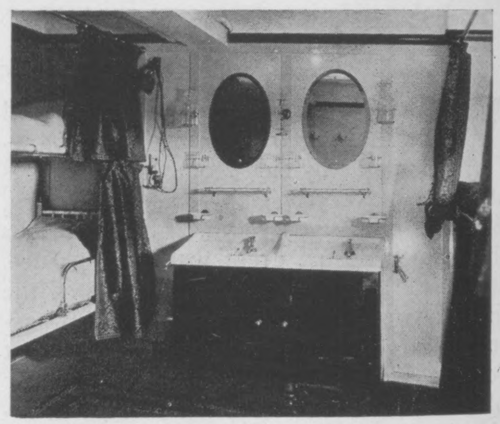


View of the engine-room from the middle platform

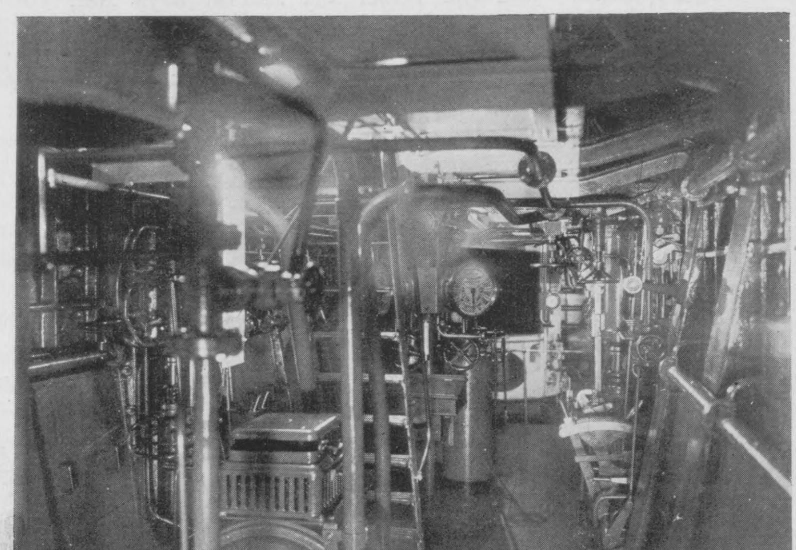
Officials and guests on the trial trip. Seated without hat is D. Mathieson representing the owners. Another American, Mr. Armor, is shown with white yachting cap

route for Panama. The tests proved highly satisfactory, and the highest speed maintained at full engine load was 12.76 knots, the fuel-consumption figuring out at 10 per cent below contract stipulations. The City of San Francisco and her sister motorship is intended for the company's trade on the west coast of America carrying, in addition to 59 first-class passengers and 60 steerage passengers, cargo totalling about 3,150 tons d.w. They are of the open-shelter deck type and plans were published on page 478 of our issue of July, 1923, when preliminary details were given.

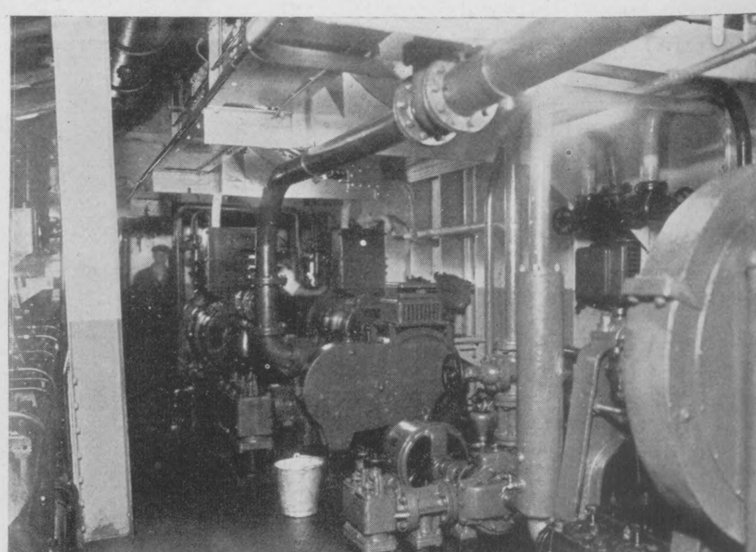
Modified dimensions are now as follows:



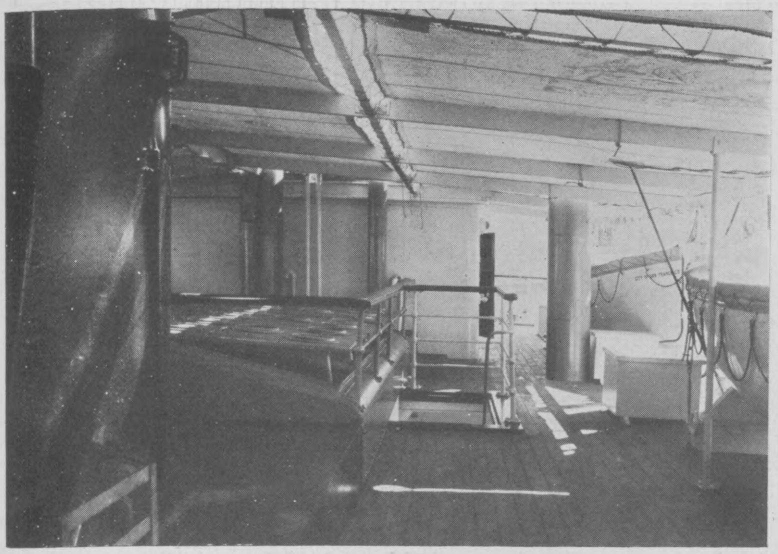
An example of the passenger accommodation on the "City of San Francisco"; first-class cabin on the shelter deck



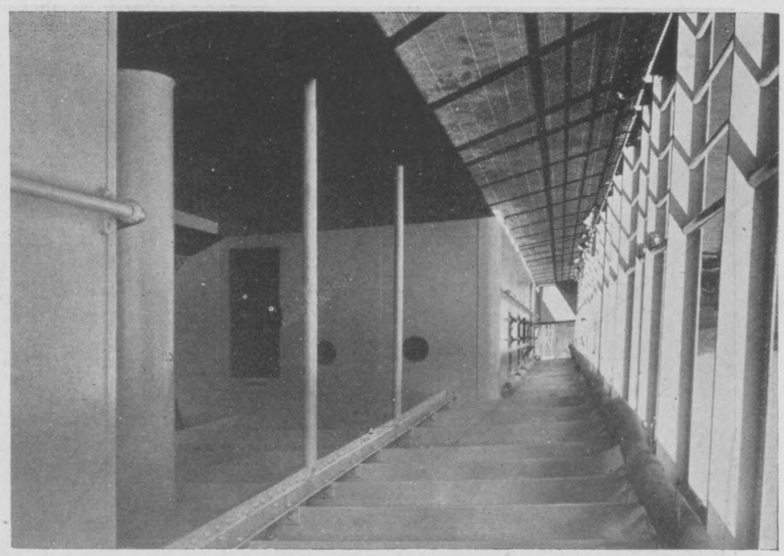
Maneuvering platform in the engine-room of the "City of San Francisco"



Electrically-driven pumps and refrigerating machinery



The boat deck



Promenade deck

Deadweight capacity	3,150 tons
Power (2 engines)	2,600 i.h.p. total
Engine speed	130 r.p.m.
Ship's loaded speed	12 knots
Cylinder bore and stroke	6x23.22"x35.43"
Length overall	314' 6"
Length b.p.	300' 0"
Breadth moulded	45' 9"
Depth to shelterdeck	30' 0"
Draft	20' 3"

Her main engines consist of twin six-cylinder Götaverken-B. & W. type Diesels of 1,300 i.h.p. each. All auxiliary machinery in the engine-room is electrically-driven, current being supplied by three 66 k.w. Diesel-driven generators, of which two are sufficient for all purposes at sea and in harbor. There is a refrigerating plant and a cold storage of 2,200 cu. ft. capacity, the refrigerator making 500 pounds of ice per day. Complete safety appliances are fitted, including a Lux-Rich fire-extinguishing system with carbon dioxide and pipes to all holds, this having been supplied by Walter Kidde & Co. of New York. In connection with this there is a smoke-detecting cabinet in the wheel-house in full view of the navigating officer. The ship has a large stack for the silencers, in contrast to most motorships built by Götaverken. Scandinavian countries—like Motorship—prefer stackless ships.

Deck looking aft, showing electric cargo-winches

Maiden Voyage of 10,252 Miles at 12 Knots Speed

New British Motorship of 19,000 Tons Displacement Averages 13 Knots Speed

Several years ago Motorship referred to the placing of orders for a series of six large "express" motorships jointly by the Holland-America and Royal Mail Lines for the Europe-Pacific coast service, and urged upon the Board to meet this competition with a fleet of even faster Diesel-driven vessels. But, the Board expressed the opinion that owing to the high first-cost of these British vessels our steamers would have no difficulty of meeting this service.

On Sept 1st, the fifth of this motorship fleet, the Lochmonar, arrived at Vancouver, B. C., on her maiden voyage from British and Continental European ports via the Panama Canal, and west U. S. A. ports, having averaged 12 knots speed for the trip of 10,252 nautical miles on a daily fuel consumption of 15¾ tons of 29-deg. Beaumé oil. For 11 consecutive days, she averaged 330 nautical miles per day, her engines during this period turning at 110 r.p.m. When we mention that this vessel has a loaded displacement of 19,000 tons, steam vessel operators will appreciate this comparatively remarkable performance.

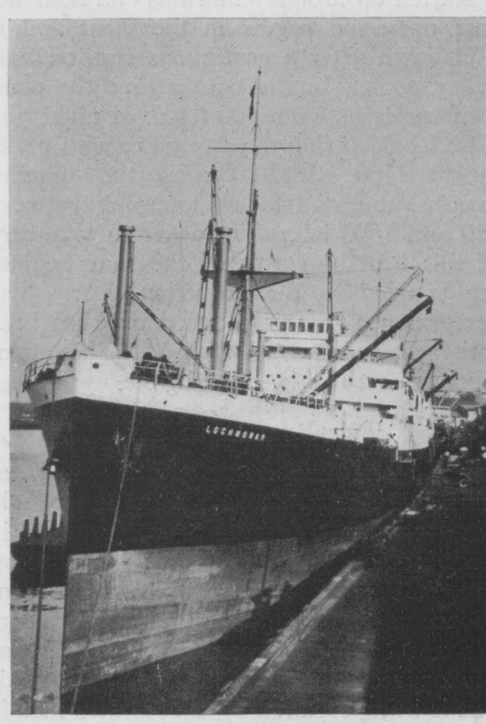
The Lochmonar has the following dimensions:

Displacement loaded	19,000 tons.
Passenger capacity	12 first class.
Refrigerator cargo capacity	2,500 tons.
Deadweight capacity	14,000 tons.
Round-voyage fuel capacity	1,200 tons.
Power (twin-main engines)	6,200 i.h.p.
Power (auxiliary engines)	500 b.h.p.
Average sea speed	12 knots.
Trial speed	13.5 knots.
Engine speed	115 r.p.m.
Daily sea fuel-consumption	15¾ tons.
Daily port consumption	¾ ton.
Length o.a.	501' 9"
Length b.p.	485' 0"
Breadth	62' 0"
Depth	39' 6"
Draft	29' 6"
Builders	Harland & Wolff.

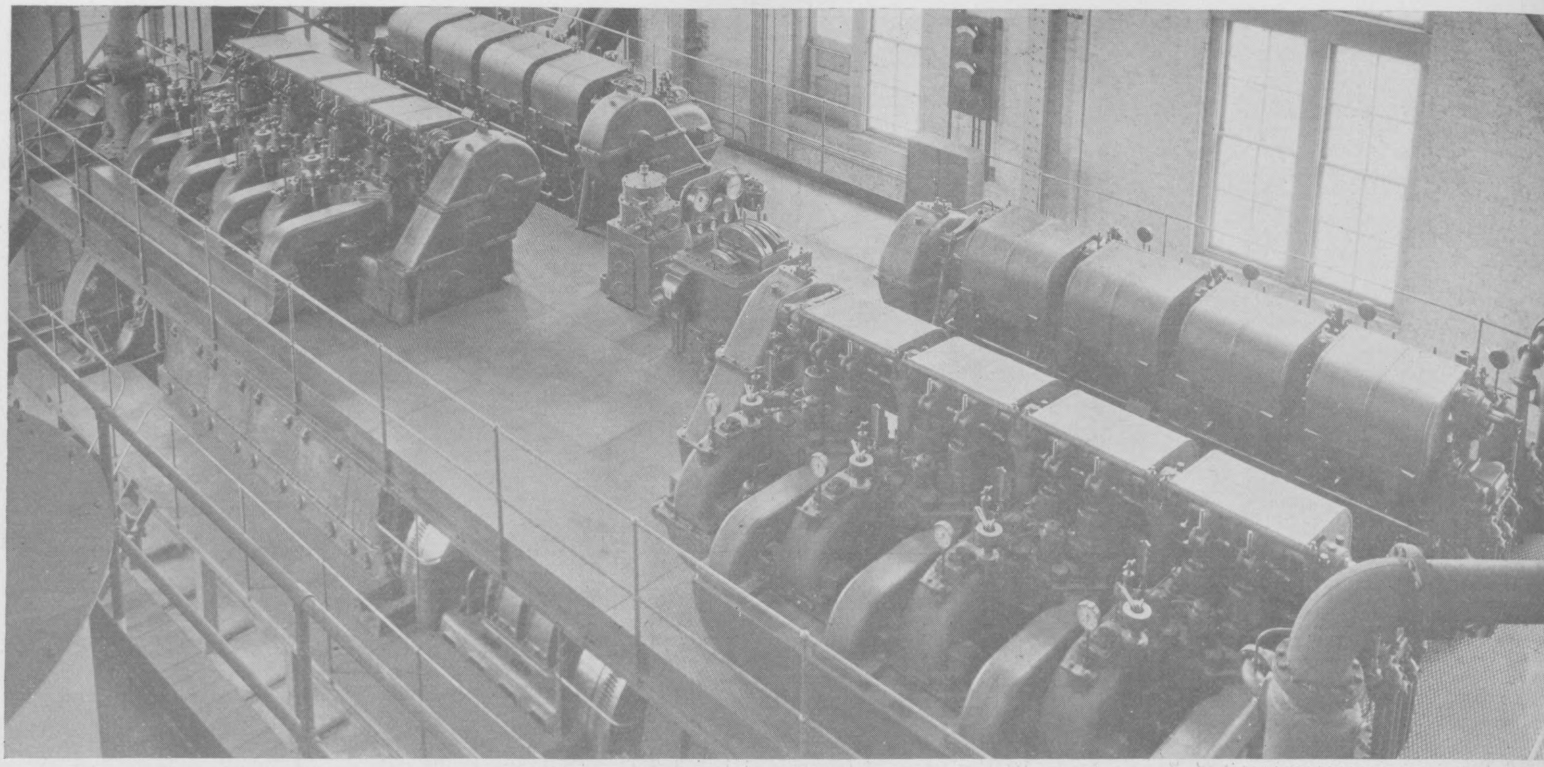
The voyage, said Chief-Engineer Brown to our Vancouver representative, was made with the engines averaging 105 r.p.m., no troubles necessitating a stoppage arising, and when the exhaust valves were taken out for examination at Vancouver they were in good shape, showing comparatively little carbon deposit. The twin main engines are Harland-B. & W. four-cycle, single-acting type, each with eight 29.134" by 45.276" cylinders. There are four 100 k.w. auxiliary Diesel generating sets furnishing current for all deck and engine-room machinery, steering gear and accommodation heaters.

There are 14 electric winches, and careful checking has enabled the chief-engineer to record a fuel-consumption for cargo handling during the two months of 4½ tons, while the oil-fired galley used 4 tons—figures worthy of comment because of the possible savings implied by them.

In view of the fact that no expense has apparently been spared in the construction and equipment of this fleet of motorships, the expectation that American steamships would be able to compete with them because of lower interest charges, does not appear to be borne out in fact.



The performance of this British motorship should be an eye-opener to many of our steamship operators



The Falk 2,200 s.h.p. reduction geared oil-engine propulsion unit to which supercharging has been successfully adapted. The electrically operated engine controls can be seen in the centre of the picture

Further Development of the Falk Geared Oil-Engine

IN the supplement to the May issue of MOTORSHIP of 1923, a record was published of the design and the successful completion, by The Falk Corporation of Milwaukee, of a new design of 4-cycle airless-injection, heavy-duty, direct-reversible marine oil-engine. As may be remembered, the experimental engine consists of four unit engines, each having four cylinders, coupled by means of Falk-Bibby couplings to a reduction gear. The cylinder dimensions are: Bore, 19″; stroke, 28″; speed, 200 r.p.m.

This engine has been operating continually since February, 1923, as a power-house unit, carrying the total Falk plant load. It is started on Monday mornings an hour before operation begins in the plant and is shut down after a continuous run, on Saturday noon. In the winter time the plant load varies between 800 b.h.p. at night and 1200 b.h.p. during the day time, with peaks up to 1400 b.h.p. During the summer months, the load is less, varying between 600 and 1000 b.h.p. In order to take care of this load only two of the four engines are coupled to the reduction gear. The performance of this reduced unit has been satisfactory in every respect. The maintenance cost has been negligible.

The Reduction Gear

The most important question was, of course, the way the reduction gear would stand up. There never was any doubt in the minds of the builders about its success, and the results have justified their confidence in a very gratifying way. There has not been any appearance, so far, of any appreciable wear on the teeth. This fact is being credited by the builders mainly to the very good protection afforded to the

Supercharging Enables Mean-Effective Pressure to Be Raised to 154 Lbs. per Sq. In. Without Slightest Sign of Ill Effect. Temperatures Are Kept Down Low Even With Uncooled Pistons

teeth by the heavy lubricant used for their lubrication. This lubricant is contained in the gear case and it may be stated that the gears are running at present with the initial filling for more than one year and a half.

Another very interesting fact in connection with the reduction gear is that the bearings of neither the pinions nor the low speed gear show any wear at all.

The flywheels of the unit engines are very light in weight and consequently there is a cyclic variation of the tooth pressure which is quite pronounced. An investigation as to the best operating conditions of the unit has revealed some remarkable con-

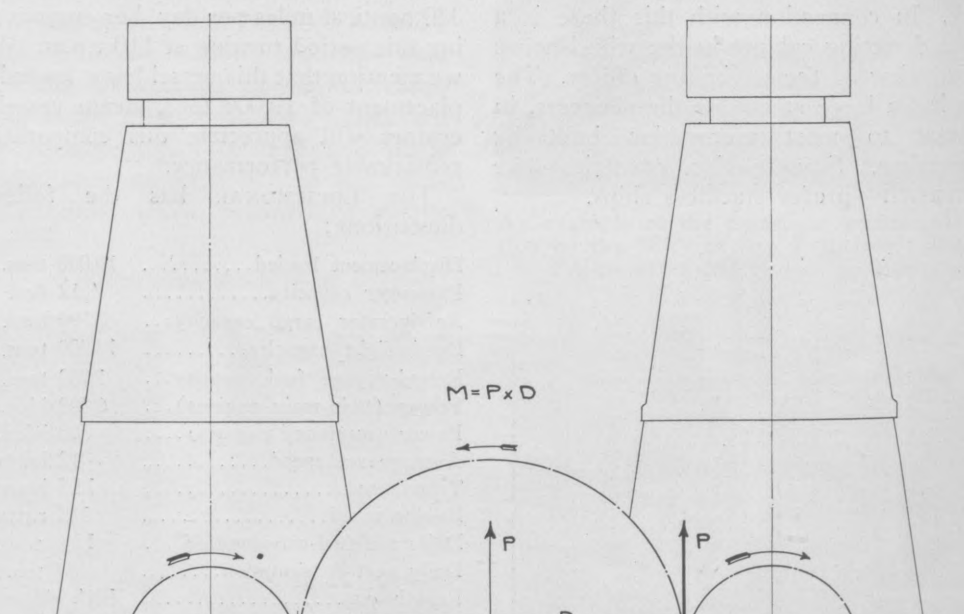


Fig. 1. Phase harmony of the crankshaft setting

ditions. The engine is a 16-cylinder unit and, being of the four-cycle type, delivers eight driving impulses per revolution of the engine crank-shafts. The cranks of each unit engine are placed in one plane and the setting of all the crank-shafts is such that the torque delivered to both pinions is at all times of approximately the same magnitude. This is obtained by setting the crank shafts for what the builders term "Phase Harmony." The special conditions in the present case require that the two crank-shafts on each pinion be set at right angles. The two crank-shafts on one pinion are set parallel to the corresponding shafts on the other pinion. It is evident from the accompanying diagram that under this condition all the load which the bearings of the low-speed gear have to carry is the weight of the low-speed gear and shaft, the reactions due to the tooth pressures on both sides cancelling each other.

This "Phase-harmonic" setting has given the reduction gear that remarkable soft and sweet-running quality which has been the greatest surprise to all who have inspected the engine.

The Couplings

At the time when the Falk-Bibby flexible couplings were built they were the largest ever produced in this country. They have been standing up extremely well, no spring has ever broken, and the contact spots of teeth and springs show just a shining, well-polished face but no appreciable wear.

Based on the experience with these four couplings, a considerable number has been built and put into operation, the largest one being installed on a motor-driven blooming mill. The rating of the latter coupling is 16,000 b.h.p. at 100 r.p.m.; its performance has been a revelation to the mill operators. Much larger couplings are now under consideration as a consequence of its truly splendid success.

Increasing the Cylinder Output by Supercharging

Since only two oil-engines are required for handling the plant load, the two other ones were free for other purposes. One of them was connected to a water brake and a research carried out to investigate the different methods to increase the cylinder output.

For a long time the four-cycle type of single-acting oil-engine has been remaining at a comparative standstill in its development towards an efficient unit of small first cost, light weight and small space. Three conditions determine mainly the size and weight of an oil-engine, all other conditions being equal.

Mean-effective pressure.
Mean piston speed.
Ratio of bore over stroke.

The four-cycle type of oil-engine lends itself particularly well to the development of high mean-effectives, high piston speeds and high ratios of bore over stroke.

When the layouts for the first Falk experimental engine were originally prepared, provision was made to investigate the possibility of increasing the mean-effective pressure by scavenging and supercharging the working cylinders, and to this effect intake manifolds were installed on every engine. After two of the engines had been put on the plant load, the work of increasing the mean-effective pressure was taken up with that unit which could be coupled to the water brake, and its manifold was connected to a Roots blower of ordinary design. The pistons on the unit engines are not cooled, but were designed with flat tops in order to facilitate the fitting of cooling arrangements in case the further developments should make this desirable. The flat top of an uncooled piston is not very well suited for heavy loads because the free expansion of the center is too much restrained by the rim. Nevertheless, the pistons have not shown any signs of distress even when operated over long periods at 77 lbs. m.e.p. on the brake.

The airless system of fuel injection seems to lend itself better to the development of high mean-effective pressures than the air-injection system. This experience has been made repeatedly and the Falk engine confirms it.

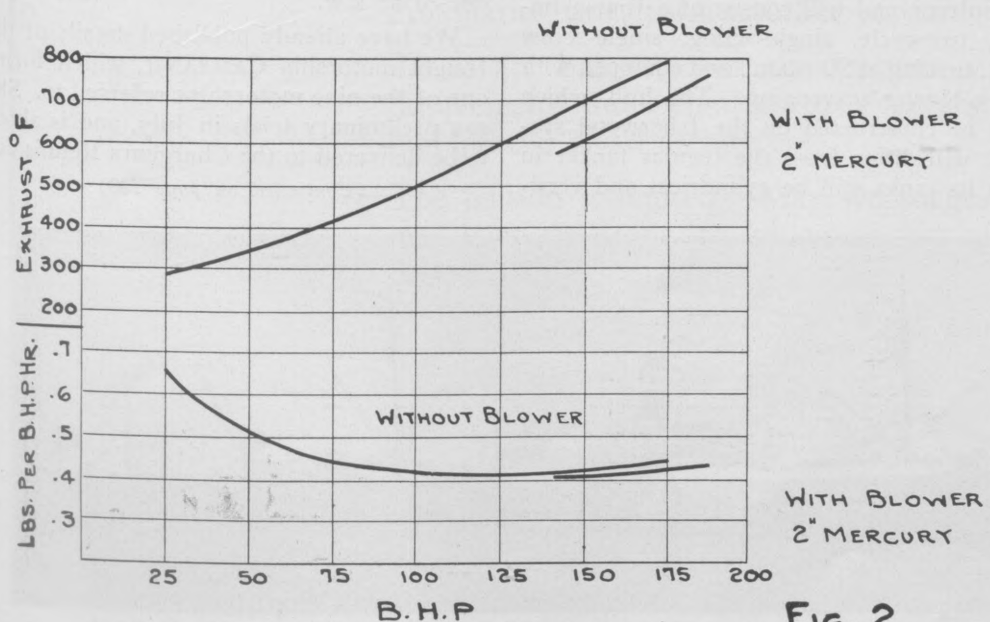
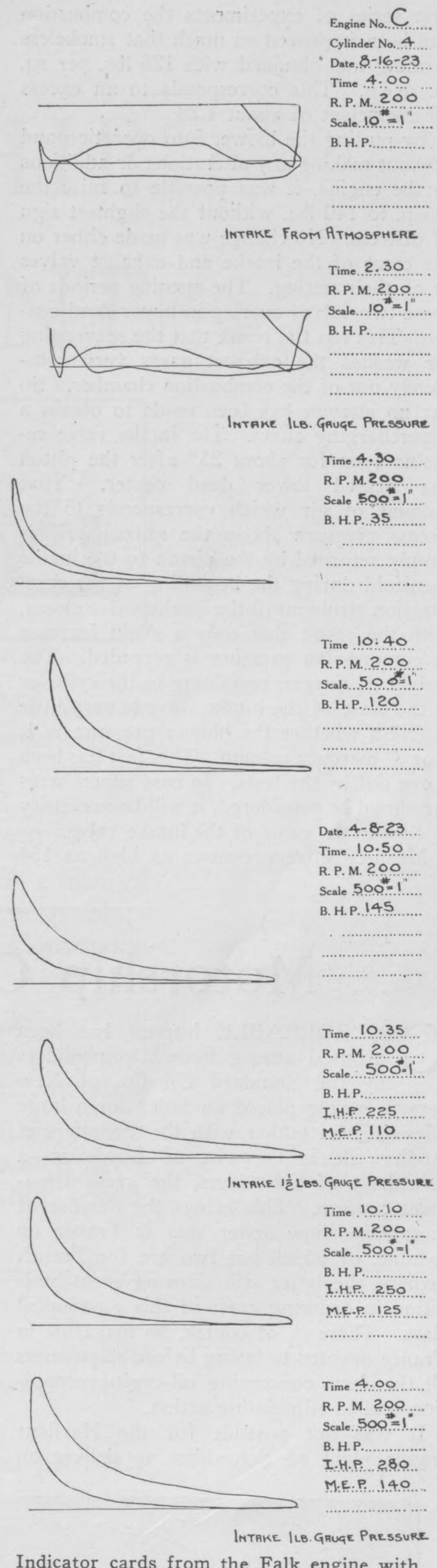


Fig. 2



Indicator cards from the Falk engine with and without supercharging

After a period of development a suitable shape of combustion chamber and sprays were obtained which gave uniformly good results from no load to maximum load. The rated load of the unit engines as originally laid down was 550 b.h.p. This means that an excess air coefficient of 1.95 was considered sufficient, which corresponds to 85.5 lbs. m.e.p. At the completion of the

first series of experiments the combustion had been improved so much that smokeless running was obtained with 125 lbs. per sq. in. m.e.p. This corresponds to an excess air coefficient of about 1.28

By putting the blower into operation and without making any alterations or additions to the engine, it was possible to raise the m.e.p. to 140 lbs. without the slightest sign of distress. No change was made either on the cams of the intake and exhaust valves or on their setting. The opening periods of these two valves overlap in upper dead center. This has the result that the scavenging air washes the exhaust gases very completely out of the combustion chamber. So far no attempt has been made to obtain a supercharging effect. The intake valve remains open for about 25° after the piston has passed lower dead center. That amount of air which corresponds to the excess pressure above the atmospheric is simply returned by the piston to the intake manifold during the beginning of the compression stroke until the intake valve closes, with the result that only a slight increase in compression pressure is recorded. The weight of oxygen remaining in the cylinder at the close of the intake valve is very little different whether the blower pressure is 1, 2 or 3″ mercury column. This fact has been borne out by the tests. In case supercharging shoud be considered, it will be necessary to change the cams of the intake valve.

Mean-effective pressures as high as 154 lbs. have been easily obtained, the scavenging-air pressure being as low as 1½″ mercury column.

It should be pointed out here that the shape of the combustion chamber as fitted on the Falk engine is particularly well suited for a very thorough removal of the exhaust gases, also that the design of the heat shield is such as to give an excellent cooling effect. This means that the incoming charge of air is kept cool and also that the shields and the cylinder heads are very well protected against heat strains. There has not been the slightest deformation observed on either of them, even after the most terrific driving of some of the cylinders.

Table 1 gives the results of a series of tests which are also represented on curve sheet No. 2. A set of representative indicator cards is also given. Cards No. 1, 2, 3, 4, were obtained with the intake manifold open to the atmosphere. Cards 6 and 7 with the intake manifold connected to the blower. The air was maintained at a pressure of 1½ pounds gauge in the first and 1 pound in the second case. All tests were made on the same cylinder with all conditions remaining unchanged except the cutting in of the blower during the last two mentioned tests.

Attention is again called to the fact that the piston was not cooled and that the original cylinder rating is 172 I.H.P. The two light spring cards 7 and 8 are given to show that supercharging is practically absent.

Table I

R.P.M.	B.H.P.	Fuel Cons., Lbs. p.B.H.P. Hr.	Exh.Temp. Deg. F.	Exhaust	Intake
200	190	0.43	750	Clear	2″ Mercury
200	150	0.41	600	"	"
200	175	0.43	800	"	Atmosphere
200	150	0.42	700	"	"
200	125	0.41	600	"	"
200	100	0.42	500	"	"
200	75	0.45	415	"	"
200	50	0.52	340	"	"

From the reports it will be seen that the heat exchange in the engine can be easily controlled and all the temperatures seem to be remarkably low, since all the tests could be carried out with uncooled pistons. With a blower pressure as low as one-inch mercury column, it will be easy to control the exhaust temperatures practically at will. In spite of these very favorable conditions, the intention is to use cooled pistons exclusively with scavenged cylinders.

Conclusion.

The results of the experiments which have been described above have confirmed the builders' confidence in each and every part of their design and this the more as parallel with them very extended series of tests have been carried out to investigate the influence of piston speed and of the conditions controlling the lubricating-oil consumption. A report about the results of this work may furnish the subject matter for a later article.

Motorship Construction Gaining in France

Nine Merchant Vessels Now on Hand, Including an Isherwood System Tanker for Standard Oil Co. with Cylindrical Tanks

CONSIDERABLE interest has been aroused among French shipbuilders by the Standard Oil Co. of New Jersey, having placed an order for a large Diesel-driven tanker with the Chantiers et Ateliers de la Gironde, of Bordeaux—a subsidiary of Schneiders, the great armament concern. This brings the number of motorships now under way in France up to nine, of which but two are for French owners, the latter still showing great hesitation in ordering craft of this economical class. There is, of course, no magazine in France devoted to laying before shipowners all the facts concerning oil-engine propulsion and to stimulating action.

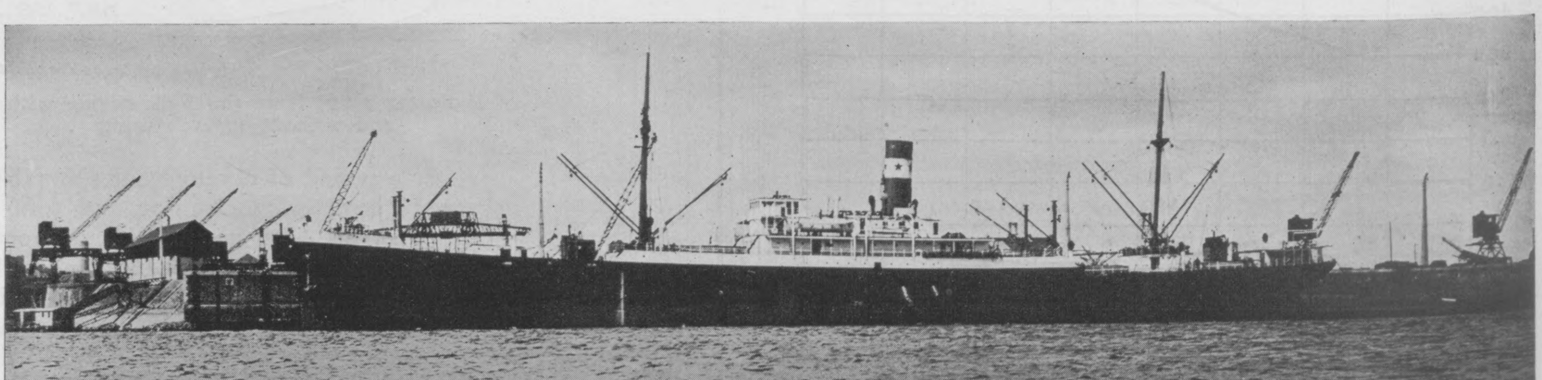
It was not possible for the Harfleur engine plant of Schneiders to deliver an 1850 shaft h.p. Diesel unit in time for the new Standard Oil tankship, owing to its exceptionally busy state on other classes of engineering work. The order for the main engine and auxiliary oil engines has gone to Sulzers, and will consist of a four-cylinder, two-cycle, single-acting, single-screw unit, turning at 90 r.p.m., and equipped with turbo-blower scavenging. The hull, which will be constructed on the Isherwood system, will differ from the regular tanker in that its tanks will be cylindrical and vertical, designed especially for the transportation of lubricating oil in bulk. The vessel has the following dimensions:

Displacement	10,000 tons
Deadweight capacity	6,450 tons
Length	406′ 10″
Breadth	56′ 3″
Power	1,850 s.h.p.
Speed	11 knots

The auxiliary engines will be two 100 k.w. Sulzer Diesel-electric generating sets and one of 45 k.w.

We have already published details of the freight motorship CAMRANH, which forms one of the nine motorships referred to. She ran preliminary trials in July, and is about to be delivered to the Chargeurs Reunis for

(*Continued on page* 738)



Motorship "Camranh" for the Chargeurs Reunis' Far East service is propelled by twin Sulzer Diesel engines of 1,700 s.h.p. each

(*Continued from page 735*)

placing in their Far East service. She was built by the Ateliers et Chantiers de la Loire, and is of 17,330 tons loaded displacement, of 11,806 tons d.w., and has 649,855 cubic feet of cargo space under decks. Two Sulzer Diesels of 1,700 s.h.p., each having a weight of 192 tons, propel this vessel, and two 410 b.h.p. Sulzer Diesel-generator sets furnish auxiliary power.

The same shipyard, as previously published in MOTORSHIP, has two other Diesel-driven ships under construction, namely, the big passenger liner, PIETER CORNELISZOON HOOFT, for the Netherlands Steamship Co., of Amsterdam, Holland, also to be Sulzer Diesel propelled.

Work is rapidly progressing on the two cargo motorships building to the order of Wilhelm Wilhelmsen, of Tonsberg, Norway, in which twin Burmeister & Wain four-cycle Diesels are being fitted at the St. Nazaire Shipbuilding Co.'s Penhoet plant. This yard is reported to have received an order for three 400-foot passenger motor liners from the Companhia Nacional de Navegacao Costeria, Rio de Janeiro. Burmeister & Wain-type Diesel engines, for which this firm has a license, will be installed in all three ships.

The ninth French motorship is the THEOPHILE GAUTIER, a passenger vessel building for the Services Contractuels de Messageries Maritimes, by the Chantiers de France. This craft, too, has Sulzer Diesel engines, of which make there are a large number up to 3,500 b.h.p. per engine in French power plants on land.

On the other hand, a notable number of orders have been placed by the French Navy, with the Compagnie de Construction Mecanique de Procedes Sulzer, St. Denis, the French subsidiary of Sulzer Brothers. These orders are chiefly relative to propelling machinery for the nine first-class submarines, which are under construction in accordance with the naval program of April, 1922, six are to be fitted each with twin, two-cycle, 1,450 s.h.p. Sulzer engines. One of these submarines, the REQUIN, was launched a few weeks ago in the presence of the new Minister of the Navy. Leflaive & Co. are building a Sabathé Diesel engine of 6,000 s.h.p. for a large submarine at their St. Etienne works, which is a record size for a high-speed Diesel engine.

Of the twelve second-class submarines, also built in accordance with the first section of the French post-war naval programme ratified by Parliament in April, 1922, four are to be fitted with Sulzer Diesel engines, comprising twin two-cycle, 600 h.p. motors in each case. The Saint Denis (near Paris) works of the Compagnie de Construction Mecanique Procedes Sulzer are very busy with the construction of these enginec. In view of France's well-known political position her demand for submarine Diesel engines is likely to increase.

New Type Red Snapper Fishing Vessel Has Oil Engine

Main Motor Power is Economical and Auxiliary Canvas Lends Operating Convenience

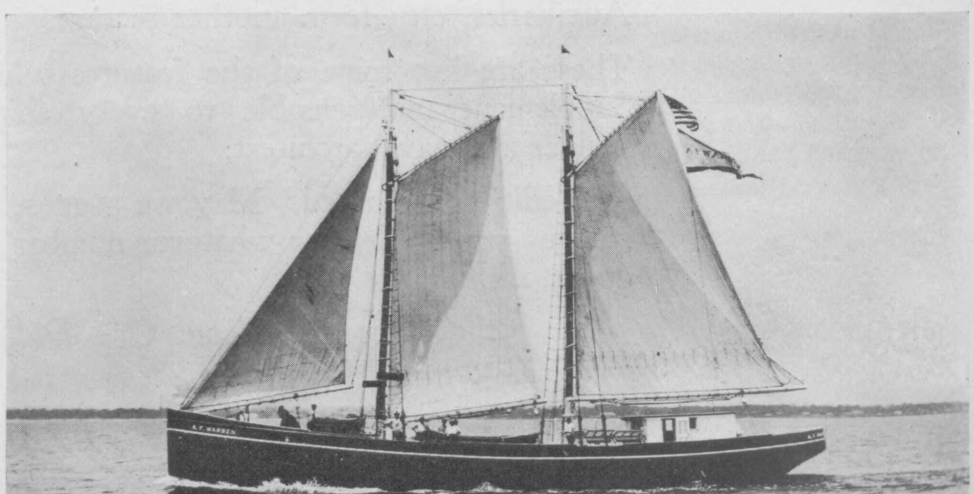
A sail-boat for fishing purposes that is safe against being becalmed and a power boat that can go for months without refuelling is the combination which has been produced in the A. F. WARREN. In addition to carrying auxiliary sails, she is powered with a six-cylinder 150-s.h.p. 8¼x11-in. Wolverine oil engine running at 350 r.p.m. as main propelling power. The sails are used when fishing, and the power is shut down.

Hull dimensions are 91x22x11ft. and she carries two masts. Built for the Red Snapper fishing service along the new lines sugggested by Capt. Wm. Frederick Wallace, editor of our associated journal *Fishing Gazette,* and author of "Blue Water," "Shack Locker," etc., she is reported as having fully met the expectations of her owners, the Warren Fish Company, Pensacola, Fla.

Since she uses only 10 gallons of fuel per hour when running at full power, it is easily possible for a boat of this size to carry a sufficient supply for extended trips. Constructed along well-established lines of four-cycle design, the engine is about as nearly reliable and fool-proof as it can be made and can be properly handled by the type of seaman who sails on fishing boats of this kind. The fact that the design is free from external ignition devices and air-injection systems makes the simplicity of its operation comparable to that of the ordinary gasoline engine.

Descriptions of this machine which have already been published gave an account of the fuel-injection system, for which individual pumps with plungers driven from the cramshaft are used. The drive to the pump plunger simply carries an extension which kicks up the end of the suction valve before the stroke is completed. Means are provided in the form of a wedge for changing the amount of lost motion between the end of the valve and the moving member attached to the plunger drive and the less slack there is the sooner the valve will be unseated and the delivery of fuel terminated. Since the wedges for all the pumps are under the common control of a substantial governor, proper regulation of the engine speed is always maintained. By the use of an auxiliary spring in connection with the governor, the speed at which the engine will run is easily controlled from the pilot house by means of a light wire cable.

A reversing clutch with levers also extended to the pilot house completes the arrangements by which the skipper maintains complete control over his vessel. Maneuvering to and from the docks is always difficult work, particularly if there is a congestion of boats; but with power directly under his control the skipper can make landings and get under way with comparative ease.



A. F. Warren, a new type of snapper fishing boat designed for the Warren Fish Company, Pensacola, along the lines suggested by Fred'k. W. Wallace, Editor of our associated publication, "Fishing Gazette"

The Depreciation Question

Sir Frederick W. Lewis at the recent annual meeting of Furness Withy, well-known shipowners engaged principally in trade between the United States and Great Britain, made some striking remarks regarding the motorship question. He said that his company's experts are making a most careful study and comparison of different types of oil-engines and with a view to determining which type is the most economical and suitable for their purposes. There is no doubt from the viewpoint of operation, stated Sir Frederick, that the Diesel engine has already established itself, but the heavy initial cost makes the amount necessary to set aside for upkeep and depreciation still unproved.

From information which has become available to date it would appear that Diesel engine depreciation is low.

Coastwise Ships, Diesel Power and Propeller Speed

Co-ordination of Propeller Design, Hull Form, and Engine Speed Will Produce Efficient and Economical Ships for Coastal Services at About the Cost of Steamers

By S. E. SLOCUM, PH.D.

CONSIDERABLE retardment in oil-engine propulsion of our coastwise passenger and freight vessels has been caused by the widespread belief that on short routes Diesel power is not an economical proposition, due to its higher first-cost more than offsetting the gain from lower consumption of fuel. And, that the weight of Diesel machinery is as high as, or higher, than steam equipment with its necessary fuel and boiler water, preventing motorships from carrying more cargo on short voyages to pay the interest on higher first charges attendant with oil-engine power.

This view of the position appears to be due to the fact that naval architects when getting out designs or making up comparison data generally have in mind the heavy slow-speed Diesel engine such as is usually to be found on ocean-going motorships. Engines of this character, however, are not required for coastwise vessels up to about 10,000 tons loaded displacement, as well-built, lighter-weight, less expensive Diesel engines with speeds varying between 100 and 200 revolutions, according to the ship, are thoroughly reliable on trips of, say, under seven days non-stop runs, and propellers can be designed to give very efficient results up to these revolutions, particularly twin screws, provided there is proper co-ordination with the hull design. Nevertheless, the latter does not mean that the hull consequently need be so fine in form that cargo spaces will be lost. On the contrary, a smaller overall size and lighter weight of the moderate speed Diesel enables more cargo to be carried than with a steam plant of the same power, such as is usually to be found in coastwise ships. In addition, the price of the machinery is reduced to a more equal level.

Until this is widely recognized the advantages of oil-engine drive on the short routes will not be felt in our coastal merchant marine. It was only recently that Admiral J. K. Robison, U. S. N., told the Propeller Club in New York that for voyages under 6,000 miles length no savings are effected by using Diesel Power. Because of the Admiral's position in maritime circles such a broad statement should not go unchallenged.

There exists, too, a great deal of misconception regarding the problem of designing moderately high-speed propellers of high efficiency. In an article on "Electric Propulsion of Motorships" published in Shipbuilding and Shipping Record (London) for June 12th, 1924, the statement is made that "nothing has so far been published to indicate that an economical propeller running at a speed of say 200 r.p.m. and driving a vessel at 11 knots, is forthcoming," and in the same journal for July 10th, 1924, there appears a letter from Admiral Taylor, U. S. N., saying that this statement "is absolutely correct."

Coming from such authorities, this would seem to settle the matter once for all, but as a matter of fact, any such remark is true only with certain limitations, and like any didactic statement, is likely to be misleading to anyone not conversant with modern methods of propeller design.

THERE is an assured volume of business in the construction, conversion, and equipping of medium-sized motor-vessels for coastwise trade because of its complete protection against foreign competition. But the advancement of coastwise motorshipping enterprises would be hampered if there is any real substance to the contention that good propulsive efficiency is inseparable from the use of relatively heavy and costly slow-speed engines. Stephen Elmer Slocum, Ph. D., a recognized consulting authority on practical propeller problems, makes a strong case for the use of the moderate speed oil engine on the basis that no arbitrary figure for rotative speed but rather a co-ordination in the design of hulls, engines, and propellers is the real secret of obtaining high efficiency.

Propeller efficiency is entirely relative to the speed of the vessel, speed of revolution, and power applied to the propeller shaft, as illustrated in what follows. Almost any reasonable propeller efficiency can be attained by varying the relation between these quantities. The real difficulty is that the ship owner or builder fixes all these quantities in advance and thereby fixes an upper limit to propeller efficiency. Thus the amount of power installed in a hull fixes an upper limit to the speed at which it can be driven; the engine builder then designs his engine to run at a certain speed, which fixes a second quantity; and the naval architect then lays out the stern frame with a propeller well which at least in the older type of steam vessels is almost invariably too small for maximum propeller efficiency at the given engine speed. There is no option for the propeller designer but to design a propeller to fit the well in the stern frame, and develop the given power at the given engine speed. If the propeller designer was consulted at the outset, it would be possible to attain a much higher propulsive efficiency than is usually obtained. This is particularly true with respect to electric drive, as the limits of practical motor speed are not so high as to lie beyond the limits of high propeller efficiency if power, speed and revolutions are properly correlated with this end in view.

The following may be mentioned as typical examples of small Diesel powered vessels which are proving highly successful in coastwise service. The "Motor Princess," a photo of which accompanies this article, belongs to the Canadian Pacific Railway, and is 170 feet in length, with a carrying capacity of 250 passengers and 40 large automobiles, and was put in service in May, 1923. The power consists of two 750 i.h.p. McIntosh and Seymour Diesel engines, driving twin screws at 200 r.p.m., which gives the vessel a speed of 14 knots.

The Isthmian S. S. Co. operate two small motorships in the Great Lakes and St. Lawrence River service, the "Steelmotor" and "Steelvendor." These vessels are 258 feet in length, with a speed of 9 knots, and are powered with one 960 i.h.p. Diesel, turning a single screw at 135 r.p.m.

The Munson S. S. Co. also operate two small motorships, the "Muncove" and "Munmotor," each of 4,125 d.w.t., and powered with one 1,200 i.h.p. Diesel engine, turning a single screw at 140 r.p.m.

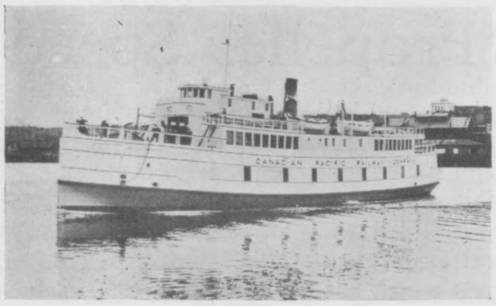
The Texas Co. operate three small Diesel-powered tankers, the "Texaco 145," "146" and "147," each 156 feet in length, and powered with a 390 i.h.p. Diesel, turning a single screw at 240 r.p.m.

The tug "Jumbo," owned by the Cornell Steamboat Co., of N. Y., is the largest direct-drive Diesel-engined towboat in the U. S. She is 100 feet in length, 26 feet beam, and is powered with a six cylinder Nelseco Diesel engine of 600 b.h.p. driving a single screw at 225 r.p.m.

In the August MOTORSHIP there was described and illustrated a 6,400 ton d.w.c. and 9,000 ton displacement Danish seagoing cargo ship, whose twin 1,100 i.h.p. Diesel engines turned her propellers at 160 r.p.m. and drove her efficiently at 10¾ knots.

Since then the new Danish twin-screw 8,000-ton d.w. motorship NORDVAHL ran trials in light condition on a draft of 11 ft. 9 in. compared with her loaded draft of 25 ft. The Diesel engines together developed 3,104 i.h.p. at 146.7 r.p.m. driving the ship at 12½ knots. This vessel's length is 380 ft. by 53½ ft. breadth. The normal speed is 130 r.p.m.

These typical examples of small Diesel-powered vessels cover a wide range of operating conditions. From the standpoint of weight, cost per H.P. and economy of space, such small units have a great advantage over the large slow-speed engines, which operate at practically the same speed as a steam engine of the same power, and may in some cases even use the same propeller. In any event the difference in propeller speed between large Diesel and steam engines is so small that they are capable of developing practically the same propulsive



Two hundred revolutions per minute is the propeller speed of this twin-screw 1,500 i.h.p. coastwise passenger carrying motorship

efficiency. It is quite generally assumed, however, that when the propeller speed is materially increased, the propulsive efficiency falls off very rapidly, and at the present time this is probably one of the chief obstacles to the adoption of small, lighter weight, Diesel engines, driving twin screws. The propeller analyses given will perhaps throw some light on this question of propulsive efficiency as related to propeller speed and remove some of the misconceptions which now prevail.

By way of comparison of propeller and propulsive efficiencies, consider first a large single-screw steamer, and a twin-screw motorship. The steamer chosen for analysis is of a type recommended by the Shipping Board for conversion to Diesel power, its principal dimensions being as follows.

Length load-water line, 410 ft., beam, 54 ft., block coefficient 0.801, midshipsection coefficient 0.975, mean draft 23 ft. 6 in., displacement 11,989 tons. At present this vessel is powered with a triple-expansion steam engine, rated at 3,300 i.h.p. at 80 r.p.m., with an engine efficiency of 0.92 to 0.95. The present propeller is a single-screw, four blades, 17 ft. 1 in. diameter, 16 ft. pitch, and 102 sq. ft. developed blade area. On its trial trip over a measured course in smooth weather and with clean bottom, the speed was 11.16 knots with 2,774 i.h.p. at 83.1 r.p.m. The writer has taken special pains to verify these data and is assured on competent authority that every item is absolutely reliable, including the high engine efficiency. The difference between the rated i.h.p. and that developed on the trial trip is accounted for on the ground that the propeller was inadequate to develop the full power of the engine.

To analyze these data, the method explained by the writed in an article written for the 1924 "Motorship Yearbook" will be used. This method is based on the fact that when propeller characteristics are accurately known, the propeller is an excellent torsion meter, more accurate than most of those applied to the propeller-shaft inboard, and that actual performance data analyzed from propeller characteristics give a much more practical and reliable index of performance than can be obtained otherwise.

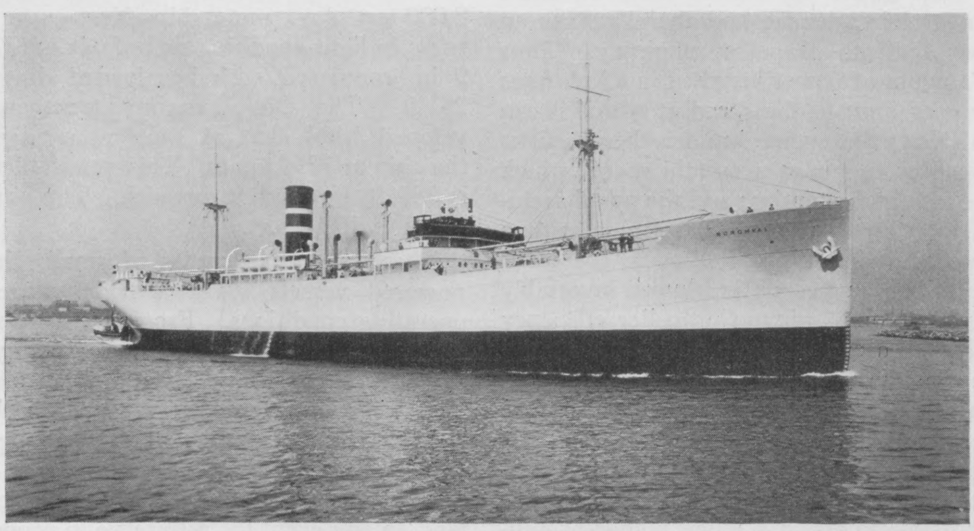
Such propeller analysis serve another very useful purpose. In Europe, where every problem in design is studied with meticulous care, a designer would hardly attempt to lay out a propeller from calculations based on the vessel's lines alone. A minimum requirement would be E.H.P. curves from tank tests, and even then the propeller designed on this basis would be called a "first approximation." From mapping the wake and a study of screw performance behind the model or vessel itself, new data would be obtained, and a propeller designed based on this information would be called a "second approximation." The method here used is invaluable for determining the effective wake, especially for the purpose in hand, as it makes it possible to design a new propeller for the converted motorship with the accuracy of a "second approximation," aside from such refinements in the elements of the design as are necessary to develop high efficiency at the higher speeds which usually accompany Diesel power.

This single-screw coastwise motor freighter has a direct driven propeller turning at 140 r.p.m. Were she a twin-screw boat the propeller speed could be increased without loss of efficiency

Concerning the effective wake as determined from propeller analysis, this represents the total resultant effect of wake on propeller speed. The wake of a vessel depends very largely on the form of afterbody, and also on the diameter of the propeller as well as its location relative to the hull. It is therefore impossible to compute the wake from hull coefficients, and in the present state of our knowledge it is very unsatisfactory to attempt to compute it from anything except actual performance data, either from self propelled tests or from the vessel itself.

PROPULSION DATA

	Shipping Board Steamer	Motorship "Kennecott"	Steamer Converted to Motorship
	TrialTrip	13,000-Mile Voyage	
Speed, knots	11.16	10.65	9
Propeller r.p.m.	83.1	130	140
Apparent slip, per cent	15	12.6	7
True slip, per cent	32.6	22	37
Effective wake, per cent	20.7	10.8	32
Propeller thrust, pounds	57,700	32,200	23,130
Hull resistance, pounds	43,850	29,060	15,270
Effective power, e.h.p.	1,500	950.4	422
Shaft power, s.h.p.	2,594	1,680	900
Propulsive coef., per cent	57.8	56.6	47



On the consumption trials of this 8,000 tons d.w. cargo motorship the twin main Diesel engines together developed 3,104 i.h.p. at 147 r.p.m. She is the Nordhval, built by Burmeister & Wain for the Norden Steamship Company, Copenhagen, propelled by twin 1,300 i.h.p. engines

Every hull, propeller and power-plant form a definite combination, such that the propeller runs at a certain definite slip. In other words, the speed-revolution curve is almost, although not quite, a straight line, which means that the slip is practically constant at all speeds up to the limit at which cavitation begins. If we can determine this slip, we have at once the key to performance, and for this reason the actual velocity of the water at different points of the propeller disc is not so important for purposes of design, as the total resultant effect of the wake on the actual propeller. The advantage of the present method of analysis is that it gives this directly, and more accurately than it can be determined from calculation, or from standardized charts, as the wake differs in individual cases and does not follow the law of averages very closely.

In applying this method of analysis to the steamer under consideration, the engine ef-

ficiency has been assumed as the average of the values given, namely, 0.935. Also, as this comparison is mainly for the purpose of comparing propeller efficiencies, the propulsive coefficient is based on the ratio of e.h.p. to s.h.p. instead of the ratio of e.h.p. to i.h.p. The results of this analysis are given in the first column of the table.

As mentioned above, these data were taken over a measured course in smooth weather and with a clean bottom. To take account of average sea conditions, it would be necessary to add about 20% to the i.h.p. Consequently, the propulsive coefficient averaged over a long voyage would have a value considerably less than that obtained from the trial trip.

It was pointed out above that it is difficult to make an accurate comparison of motorship and steamer. Their relative propulsive efficiencies, however, may be compared quite easily. For this purpose we will not attempt to find two vessels exactly alike, but rather representing the types in question. The single-screw, slow revolution steamer is a standardized type. The twin-screw, higher revolution motorship is also becoming a standardized type, and as representing this type the m.s. "Kennecott" has been chosen as most suitable. Her principal dimensions are as follows: Length, 360 ft., beam, 49.5 ft., mean draft, 23 ft. 5 in., loaded displacement, 8,425 tons, power two McIntosh and Seymour Diesel engines, rated at 1,200 i.h.p. each, at 140 r.p.m., turning four bladed twin screws, 11 ft. 6 in. diameter, by 9 ft. 6 in. pitch, with a developed area of 32.5 sq. ft. per blade. The performance data will be taken from the log of voyage No. 2, covering a period of over 90 days, and a distance of 13,020 nautical miles. The average speed for this voyage was 10.65 knots, with an average of about 840 s.h.p. on each screw at 130 r.p.m. Applying the same method of analysis to these data, the results are given in the second column of the table.

For a long voyage in actual service, this twin-screw motorship shows up practically as well as the steamer on its trial trip. As regards pure propeller efficiency, this of course may be represented in various ways, but for practical purposes it may be regarded as a function of pitch-ratio and true slip. For the steamer considered above the pitch-ratio is higher than for the motorship, resulting in higher efficiency, but the true slip is also higher, which lowers the efficiency. The result is that under the given conditions the propeller efficiencies are almost equal, whereas rough weather, which would increase the slip specified for the steamer, would lower its propeller efficiency as well as its propulsive coefficient.

It is interesting and instructive to compare the performance of the twin-screw motorship "Kennecott" with that of a single screw motorship, powered with the same type of engine at the same speed of revolution. The name of the latter vessel is withheld, as the owners regard all performance data as confidential. The motorship in question is a former Shipping Board steamer, 250 ft. in length, and since its conversion to Diesel power has been employed along the coast in general trade. It is powered with a Diesel engine developing 1,200 i.h.p. at 140 r.p.m., and turning a single four-bladed propeller, 11 ft. 3 in. diameter by 7 ft. pitch, which gives the vessel an average speed of about 9 knots. Analysis of these data gives the results indicated in the third column of the table.

Note that this motorship has exactly the same s.h.p. per engine and r.p.m. as the "Kennecott." The notable difference in their propulsive coefficients is due to two causes; first, the higher wake of the single-screw vessel, which results from the type of hull and location of propeller; and second, the very fine pitch of the propeller which might easily be improved by proper design. This brings out forcibly that the effectiveness of motorship conversion depends very largely on propeller design. It is interesting to note that the first propeller installed on this vessel after conversion to Diesel power was only 8 ft. 9 in. diameter by 7 ft. 5 in. pitch, and that a sister motorship carries a propeller 10 ft. 9 in. diameter by 7 ft. 2 in. pitch. The pitch ratios tried therefore differ rather widely, being respectively 0.62, 0.67 and 0.85. As a matter of fact, for each combination of hull and power plant there is a definite pitch-ratio which gives best results and which can be determined very closely in advance. This correct choice of pitch-ratio is the chief reason for the superior performance of the "Kennecott."

As a further example, consider an actual case of a vessel of 11 knots speed, as specified in the article referred to above from Shipbuilding and Shipping Record. This example is based on the data for a Shipping Board vessel now being converted to Diesel-Electric drive, for which the writer recently designed the propeller. In this case the given data were V=11 knots, s.h.p.=2,400, r.p.m.=100, and the maximum propeller efficiency for a propeller of conventional design was found to be 0.535. It may be mentioned in this connection that the efficiency was considerably improved by designing a modern propeller of varying pitch and other improved features, which are especially effective with slow speed vessels.

To show the effect of varying these quantities, first change the speed; that is, suppose the hull to be finer or of less displacement so that the same power would give a speed of 13 knots. Also let the propeller efficiency be maintained at 0.535, and solve for the corresponding r.p.m. In this case then the data are V=13 knots, s.h.p.=2,400, e=0.535, and from these we find the corresponding r.p.m. to be 152.

Next keep the speed at 13 knots, but make the r.p.m.=100 as in the original problem, and find the corresponding maximum efficiency. The data now are V=13 knots, s.h.p.=2,400, r.p.m.=100, and from these we find the maximum propeller efficiency to be e=0.58.

As a fourth case, suppose that we divide the power up between twin screws, or install half the power in a lighter hull at the same speed of 13 knots. The data now are V=13 knots, s.h.p.=1,200, r.p.m.=100, and the corresponding propeller efficiency is found to be e=0.605.

In smaller vessels it is often desirable to run the revolutions up to a higher value than 100. Suppose therefore that we fix the r.p.m. at 152, as in the second case. The data now are V=13 knots, s.h.p.=1,200, r.p.m.=152, and the corresponding maximum efficiency is found to be e=0.57.

These five cases illustrate the possibility of obtaining favorable propeller efficiencies with high revolutions for suitable power and speed. In particular it shows that highly efficient results can be obtained with direct Diesel, or Diesel-electric drive with vessels of moderate power and speed, especially with twin or multiple screws. The efficiencies specified in this illustration are in each case for propellers of conventional design and constant pitch, and can be bettered by 10 per cent or more by modern methods of design.

Sudden Death of Well-Known Diesel Engineer

It is with deep regret and a sense of irreparable loss that we record the sudden death of Hans R. Setz, engineer in charge of special Diesel engine development work at the Sun Shipbuilding & Dry Dock Company. Chester, Pa. He passed away at his home on September 6th, leaving behind his widow, Mrs. Setz, and two sons.

Born at Biel, Switzerland in 1880 he received his mechanical engineering degree from the Polytechnicum Zürich at a remarkably early age and took a course in practical work at the Sulzer plant in Winterthur. He migrated to America in 1902 and after receiving his first employment in the steam-turbine department of the Westinghouse Electric & Machine Company, was soon afterwards transferred to the gas-engine department of that company.

He is perhaps best known for the line of engines which he designed and put into operation for the Fulton Iron Works of St. Louis. Many of these plants are spread throughout the country and form impressive monuments of Mr. Setz's achievement.

Several years were also spent by him as chief engineer of the Diesel Engine Department of the Manitowoc Shipbuilding Company, developing an American modification of the Tosi Diesel engine, and after the termination of his connection with this firm he devoted two years of his own time to perfecting his designs for a double-acting two-cycle engine. He occupied this position with the Sun Shipbuilding Company since February of this year developing this engine.

All those who knew Mr. Setz had a deep personal regard for him and he had the gift of endearing himself to all those with whom he came in any kind of contact by whom he will be mourned and missed.

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Conversion of Our Coastwise Steamers

THERE is still a large section of our coastwise shipping interests not yet impressed with the valuable economies of oil-engine propulsion for cargo and passenger ships for their particular services, and the task of converting many of these old steam men is even more formidable than the task of planting the Diesel idea into the minds of shipowners whose vessels are engaged on foreign routes. Protected by the Panama Canal Treaty our coastwise shipping has no competition other than within itself, and the various services are fairly well defined and divided among the different domestic companies. They are not faced with the problem of seeing foreign ships coming into our harbors, moor at the docks, and take away American products as cargoes under their very noses due to the lower cost of operation and to the efficiencies of more modern types of vessels.

Nevertheless, oil-engine drive is making positive, even if slow headway in coastwise traffic and the successful results of motor craft already in service are not likely to be thrown lightly to one side. Those coastwise shipowners who at the present time show practically no interest in this type of power will be obliged, by the very law of economics, to give the question far deeper consideration in the immediate future. It may be a year, it may be five years or even a little longer before extensive conversions of existing passenger and cargo coastwise ships will be commenced.

Regardless of what happens to our vast foreign-going merchant marine, our coastwise, inland waterway and harbor shipping and workboat industries will always form the backbone of our maritime affairs. Moreover, in this direction the greatest market for domestic oil-engine manufacturers and shipbuilders will be found. Our unfavorable shipping laws coupled with our high cost of production unfortunately has driven orders of much of our foreign going shipping to foreign yards. This may be changed later. But the future of our coastwise and internal shipping appears to be so impregnably fortified by legal status and by circumstances that a high degree of confidence may be placed in it. It is growing with the increasing prosperity of the country. Like the independent and self-contained internal-combustion generating or compressing set such is generally installed on motor-vessels, it is always ready at hand to avert a complete shut-down of our yards and marine-engineering facilities, and often to render them very busy.

Elaborate discourses are made public from time to time in which an attempt is made to show that capital charges eat up the savings made by those oil engines installed in small boats or in coastal vessels of moderate size which make short runs, and therefore spend a large proportion of their time in port. There can be no doubt that the longest voyages yield the largest savings, not only because of the greater yearly load-factor applying to the oil-engine installation, but because of large amounts of valuable cargo space occupied by the fuel required for an equivalent steamer.

Nevertheless, evidence appears to be multiplying in support of the view that the oil-engines also effect substantial savings when they are used for short-haul craft. Even with tugs which carry no cargo, enormous—proportionately—economies have been effected by oil-engine drive. Were this not the case, the oil-engined fishing-boat, ferry-boat and the work-boat would have gone out of existence sooner than the various larger coastwise motorships already in service. The facts in the case show that even the smallest craft making individual trips of infinitesimal magnitude in comparison to coastwise voyages are increasing at so rapid a rate that any attempt to keep pace with them is futile. The first and maintenance costs per horsepower for the smaller installations is not materially different from that of the larger ones and interest charges have certainly not kept the little fellows from multiplying at an astonishing rate.

Another bugbear unnecessarily conjured up and which may be unfavorably regarded by a shipowner giving thought to Diesel power for his new coastwise vessel is that the heavy slow-speed units such as are used in ocean-going cargo ships—whose machineries often have to plug away on non-stop runs of 25 or more days at a time—occupy so much space, weigh so heavy, and are so expensive that the benefits derived from lower fuel consumption are outweighed. Modern methods of propeller design, however, may confidently be expected to produce wheels having at least standard efficiency and running at revolutions compatible with the use of medium-speed, crosshead or trunk-piston oil-engines having lighter weight and occupying less room and having a comparatively low investment cost. This question of propeller speed is ably discussed by a naval architect elsewhere in this issue.

Of recent years the orthodox propeller theory has been smashed to a great extent and good efficiency can be obtained at considerably higher speeds than heretofore agreed, as witness the interesting experiments carried out some time ago by a big Danish company, which has resulted in their building 9,000 tons displacement motor-freighters, with propellers turning at 160 r.p.m.

Where medium-speed Diesel engines are adopted for coastwise vessels of average tonnage, the use of twin screws is to be recommended, as it enables the wheels to be more deeply emersed and arranged at positions where they will receive an unobstructed flow of water. The higher cost of a twin-screw installation and hull construction are more than offset by the advantages of better ship's speed, particularly when the vessel is running light, absence of propeller racing, more rapid maneuvering and rapid docking without the aid of tugs, aside from the question that in case of mechanical trouble or loss of propeller blades the vessel can always proceed at reduced speed with the second engine—giving an additional reliability feature. As recognition of the value of this practice becomes more common, objections against the coastwise motorship will be robbed of their last vestige of plausibility. Then conversion on almost wholesale scale will start.

There are two reasons why the use of the medium-speed engine type effects a reduction in first cost. It is generally possible to supply the required amount of power by means of trunk pistons and to dispense with the more expensive crosshead structure. In addition, the higher rotative speed allows the engine to produce a larger number of working impulses per minute, which also signifies a lower investment cost per horsepower.

New Standard Oil Motorship Fleet of Over One-Sixth Million Tons

Fourteen Diesel-Driven Vessels Building in Europe for Subsidiaries of the Standard Oil Co. of New Jersey

WITH the possible exception of the big fleets for the Bank and Wilhelmsen Lines, never before have so many motorships been actually under construction at one time for one concern as are building to the order of interests associated with the Standard Oil Co. of New Jersey. It is true that large numbers of motorships have been ordered by one company, such as the East Asiatic Co., North Star Line, Glen Line, and the Grangesberg-Oxelösund, but in these cases the construction has been spread over periods of five or six years, whereas the Standard Oil boats are all on the ways or just delivered, involving the immediate outlay of a very large sum of money. Unfortunately, for American shipyards and oil-engine plants, these orders have gone to Europe, due to the much lower cost of construction, as well as to our unfavorable shipping laws.

The new Standard Oil program, if we include the PHOEBUS and PROMETHEUS, recently commissioned, but excluding the domestic-built Diesel-electric driven coastwise tanker J. H. SENIOR, consists of 14 motor tankers, aggregating 172,280 tons deadweight and 40,650 shaft horsepower. Sulzer, M. A. N., and Krupp makes of Diesel engines are being installed in the various ships. All the engines are of the four-cylinder, two-cycle type with the exception of the two Krupp units in the PROMETHEUS, which are four-cycle units in six cylinders. All are twin screw excepting the 6,450 tons tanker for lubricating oil carrying. The shipyards are the Vulcan Werft, of Hamburg; Krupps of Kiel, and the Gironde S. B. Co. (Schneider et Cie.), Bordeaux.

In addition to these fourteen tankers, the Standard Oil Company has placed orders with Krupps of Kiel for three Diesel engines of 2,150 s.h.p. each which are to be installed in the four-year-old reduction-geared turbine tankers TRONTOLITE, JOSIAH MACY and S. B. HARKNESS. This brings the total horsepower of the Diesel engines now on order for this company up to 47,100. The tankers can be classified as follows:

List of Motorships Building for Standard Oil Interests, not Including Three Conversions

	German-American Petroleum Co., Hamburg	German-American Petroleum Co., Hamburg	American Petroleum Co., The Hague	American Petroleum Co., Antwerp	Imperial Oil Co., Toronto	German-American Petroleum Co., Hamburg	Bedford Petroleum Co., Paris
No. of Ships	2	2*	2	1	2	4	1
D. W. Tonnage per Ship	15,600	13,370 and 13,260	12,000	12,000	12,000	12,000	6,450
Power (Shaft)	3,200	3,200 and 3,100	2,900	2,900	2,900	2,900	1,850
Length, B. P.	509′ 6″	500′ 0″	469′ 6″	469′ 6″	469′ 6″	469′ 6″	384′ 0″
Breadth, Md.	68′ 0″	64′ 0″	63′ 0″	63′ 0″	63′ 0″	63′ 0″	55′ 9″
Depth	38′ 0″	39′ 4″	35′ 0″	35′ 0″	35′ 0″	35′ 0″	28′ 6″
Engine Speed	90 r.p.m.	90 r.p.m. and 125 r.p.m.	90 r.p.m.	90 r.p.m.	90 r.p.m.	90 r.p.m.	90 r.p.m.

* PHOEBUS and PROMETHEUS.

Change of Power Revitalizes Salvaged Tug

The Zoe is the Only Sea-Going Motor Tug-Boat in Galveston

The largest and most powerful tug of her type in the South has just been completed at Elliott's Shipyard, Harrisburg. She is the ZOE, belonging to the Bay Towing Company of Galveston. The ZOE was built in Mobile, Ala., in 1903. Originally a steam tug, 72 feet long, 17 feet beam and eight feet draft, she was later lengthened and is now 87 feet long, 17 feet breadth and has a draft of nine feet.

Last November the ZOE was towing a string of loaded shell barges from Galveston Bay to the cement plant in Manchester, and when off Norsworthy, caught fire. She sank in a few minutes, was later raised, pumped out and tied up pending decision of the owners as to her disposition.

The Bay Towing Company and W. D. Haden and Company had had much experience with ownership and operation of heavy-oil engines, and, although the ZOE was much larger and would require much more power than any of the motor tugs they then had, the question came up whether to refit her as a steam tug or take out the steam boiler and engine and substitute a heavy-oil engine.

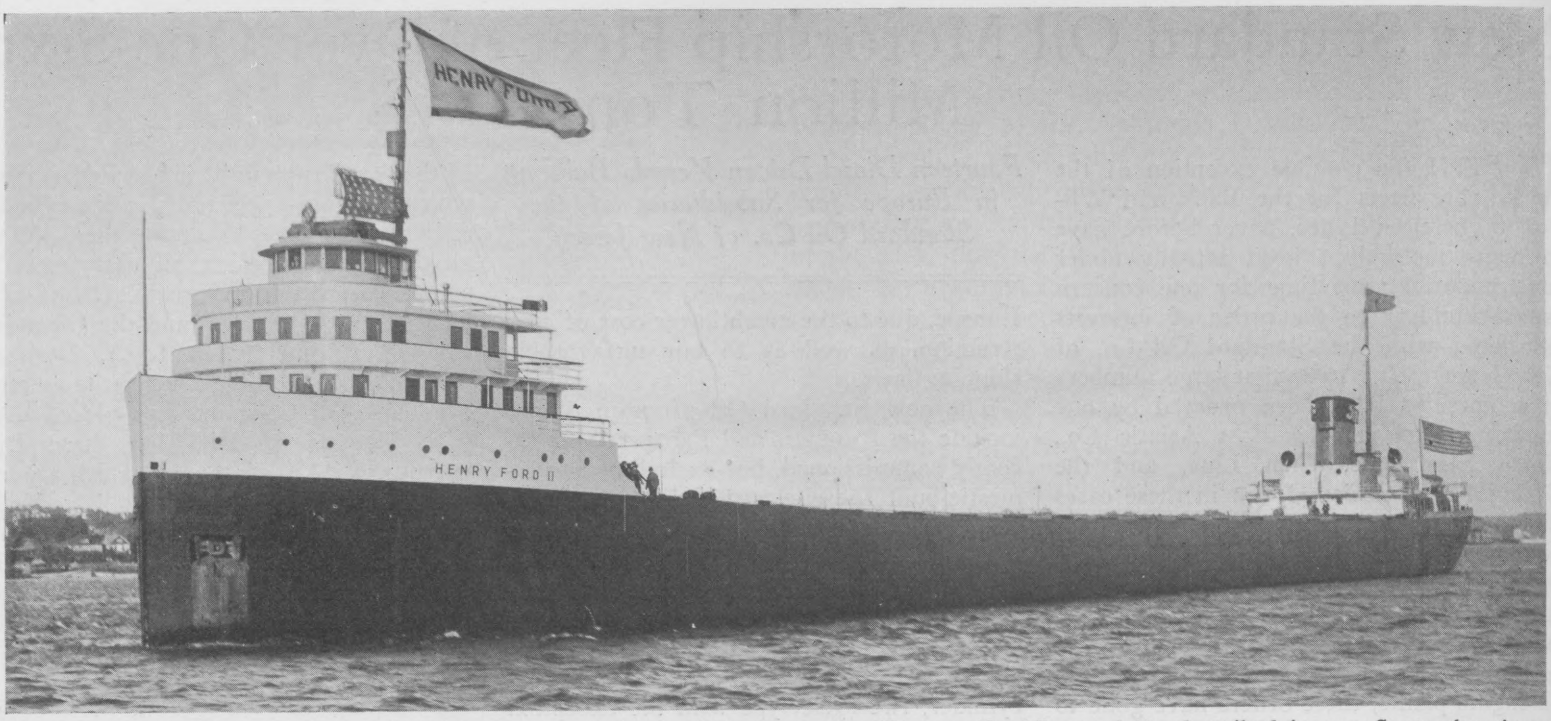
After considering the question the owners decided to put a Fairbanks-Morse oil engine into the old hull. The engine selected was a six-cylinder, direct-reversing engine of 300 rated horsepower.

The auxiliaries consist of an air compressor, Gardner type, run by a Cushman gasoline engine, a Viking fire pump and a Rumsey centrifugal pump, both operated through clutches by the same Cushman gasoline engine, and a Western Electric light plant. She has a fuel tank capacity for 12 days of running at full speed, making 12 knots per hour, running light.

As a steam tug she could not go more than three days on a full supply of fuel oil, as extra feed water for the boiler had to be carried also. She now carries two less men than as a steamer.

Fire damage to the former steam-tug "Zoe" was more than made good by refitting her with an oil-engine

The Bay Towing Company now has the largest and most powerful internal-combustion tug in the South. The ZOE will be the only oil-engine tug licensed to do outside work in the Gulf, and is expected to show owners that she can compete with the steam craft in doing long distance towing, now practically monopolized by large steam tugs.



Bow view of the "Henry Ford II," which vessel, together with a sister ship "Benson Ford," was fully described in our September issue

Interesting Notes and News From Everywhere

World's Record of New Construction. Ships' Performances and Other Matters of Note in the Motor Vessel and Oil Engine Industries

ENDYMION, Sir Herbert Samuelson's new 138 ft. motoryacht, is propelled by twin 270 s.h.p. Bolinder oil-engines.

"X. I.," Britain's super submarine-cruiser, ran sea trials last month. She is of 3,600 tons displacement, and has five 5″ guns.

While still on the ways, the new French submarine REGNAULT was converted from steam turbine to Sulzer Diesel-engine power.

The 2,800 s.h.p. main Diesel engine of the LIO will be built at the Union plant, San Francisco, of the Bethlehem Shipbuilding Corporation.

A 350 s.h.p. Kromhout reversible oil-engine will be installed in a small vessel by the Taikoo Dockyard & Engineering Company, Hong Kong.

The War Department at Portland, Oregon, is installing two 165 s.h.p. Enterprise Diesel engines in two new tugboats built at that city.

The Compania General de Combustibles, Buenos Aires, is reported to have ordered a 10,200 tons deadweight motor-tanker from the Northumberland Shipbuilding Company, to have Wallsend-Sulzer Diesels.

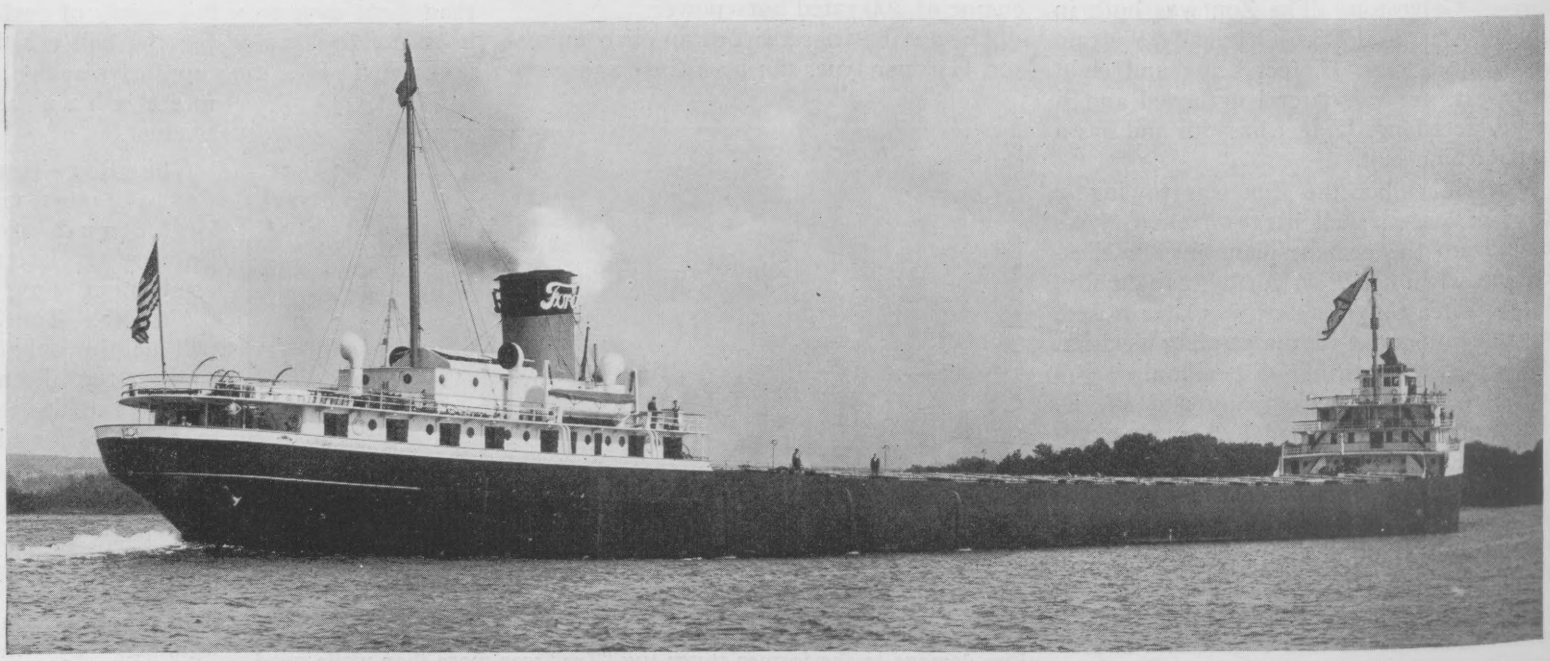
The Tacoma Tug & Barge Company recently placed an order for a tow-boat to be equipped with a new 125 s.h.p. Sumner oil-engine at the Crosby Shipyard, Lake Union, Seattle.

Large Diesel-driven yachts on the Pacific Coast until recently could be counted on the fingers of one hand, but the demand for this type of vessel is steadily increasing in the west.

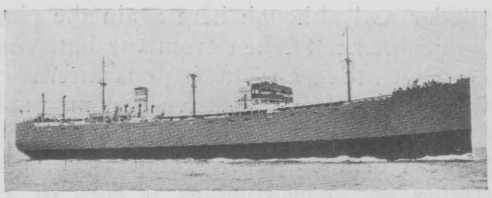
Both the MONTE SARMIENTO and the MONTE OLIVIA, new motorships of the Hamburg-South America Line, are of 14,000 tons gross and 7,000 shaft h.p. They have high-speed Diesel engines in conjunction with reduction gears.

On August 30th, the 116′ by 20′ by

(*Continued on page* 749)



This view of the motorship "Henry Ford II" shows her to have more graceful lines than the average lake freighter



"Silverlarch," another motorship for the Roosevelt Steamship Line of New York, built by Swan, Hunter & Wigham Richardson, Ltd., Newcastle-on-Tyne. She recently arrived in New York on her maiden voyage

7' motor yacht was launched at the Todd Drydocks, Seattle, to the order of C. W. Wiley. The ALICAN, as this craft is named, is powered with twin 150 b.h.p. Winton four-cycle Diesel engines.

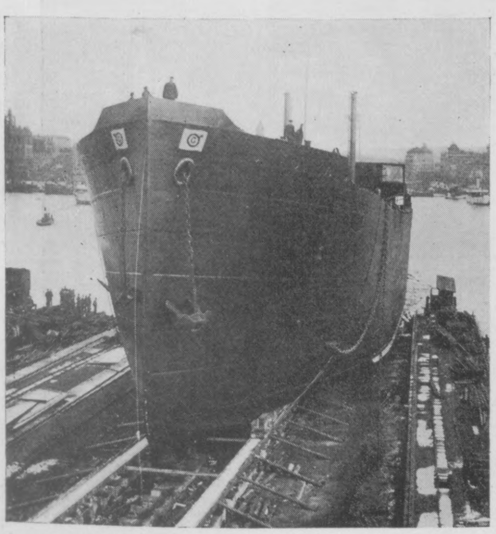
Bunkering at Los Angeles Harbor for the round voyages of the big British and Dutch motorships KINDERDYK, LOCHMONAR, LOCHKATRINE, DRECHTDYK, DINTELDYK *and* LOCHGOIL is being carried out by the Shell Oil Company when the vessels call at that port.

On August 8th, the new ore-carrier PAJALA for the Grangesberg-Orelösund was launched at the Götaverken. This is the ninth ship of the eighteen ordered from this concern. Two Götaverken-B. & W. Diesel engines, aggregating 2,000 i.h.p., will be installed.

The MYSTIC C. and WM. V. MCDONALD, fishing boats owned by the Saunders Fish Co., Pensacola, have been equipped with 75 b.h.p. Automatic oil-engines. A similar engine will shortly be installed in this company's fishing boat the VIRGINIA.

There actually is one steamship under construction in Sweden—we were advised by the superintendent-engineer of a leading Swedish shipowning company when recently in the United States. This vessel is of about 2,000 tons deadweight.

RIO BRAVO, the Ocean Line's (Flensburg) new passenger-and-cargo motorliner trading between Hamburg and Mexico has two stacks, and is the first Diesel ship to be thus equipped. She is 410' by 51' 9" by 27' 6" and a speed of 14 knots light was obtained on trial. A sister motor liner is completing at Krupps.

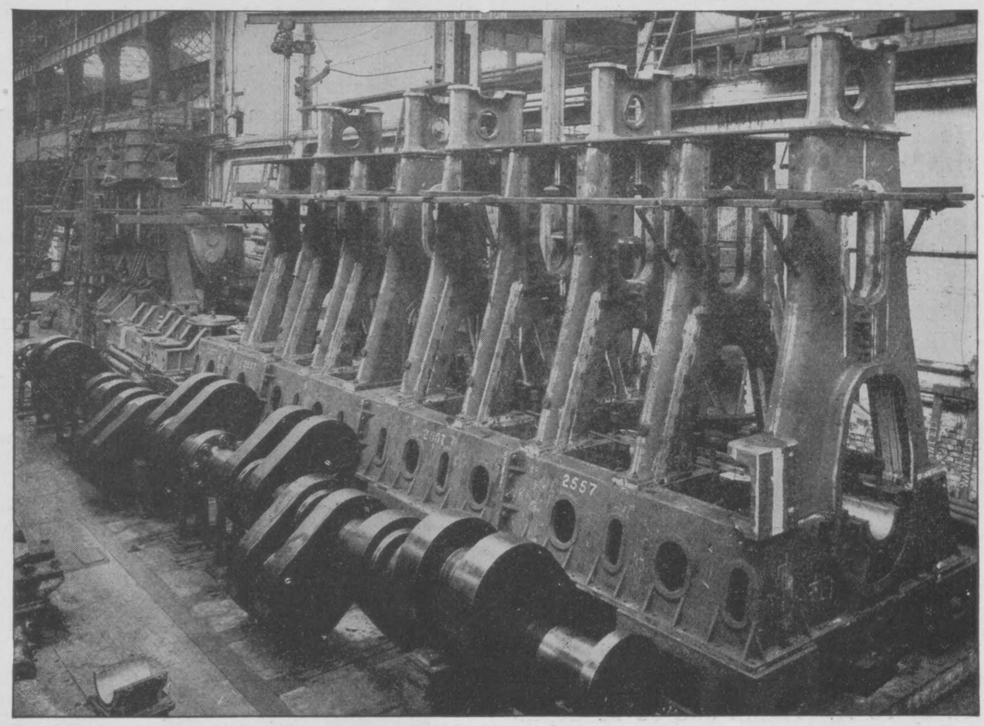


Launch of the ore-carrier "Pajala" at the Gotaverken

Twin 180 s.h.p. Winton 6-clinder Diesel engines will be installed in a new motor-yacht under construction at the Consolidated Shipbuilding Corporation's yard, New York, to the order of Walter A. Briggs, Detroit, Michigan. Oil-engined electrical auxiliaries will be installed.

In a 4,600 tons d.w. motorship just ordered by Burns, Philip & Co., from Barclay, Curle, of Glasgow, a Kincaid-B. & W. Diesel engine will be installed. There will be accommodation for 100 passengers. Dimensions, 355' long, 49' breadth and 25' depth.

"Scandinavian shipowners are selling their steamships and buying motorships as rapidly as possible, and they are talking Diesel engines day and night," said Albert Moore, President of Moore & McCormack, New York and San Francisco, following his six weeks' trip to Northern Europe.



Framework of new design of slow-speed North Eastern-Werkspoor four-cycle Diesel engine of 2,400 s.h.p. from eight cylinders 28.74" diameter by 51.18" stroke, turning at 92 r.p.m. This engine will be installed in a single-screw cargo liner of 8,000 tons d.w. building at Dundee, Scotland, for the Lancashire Shipping Company of Liverpool. The crankshaft in the foregroud is of a built-up type

BIRCHBANK, another twin-screw 5,200 gross tons motorship for the Bank Line was delivered to her owners on Sept. 4th. Harland-B. & W. Diesel engines are installed. The COMLIEBANK, a motorship of the same tonnage for the same owners, was launched by Harland & Wolff the previous day.

The Pacific Mail Steamship Company's new liner the CITY OF SAN FRANCISCO, recently completed sea trials and has left Gothenburg, Sweden, on her maiden voyage for the Pacific Coast via the Panama Canal. On trials a speed of 12¾ knots was developed. She was built by the Götaverken and has Götaverken-B. & W. Diesel engines.

Built for Service in the Far East, a 115-ft. passenger and cargo motorship has just been completed at Greenock, Scotland, and equipped with a 270-s.h.p. Bolinder oil-engine. The ARANGAM, as the vessel is named, was shipped in pieces to Penang and erected there. The weight of the machinery and fuel for seven days does not exceed 30 tons, whereas a steam plant and its necessary fuel would weigh over 80 tons.

A rumor was recently current in shipping circles that the single-screw, opposed-piston oil-engined motorship, YNGAREN, was held up at a Pacific Coast port due to cracked cylinders. It transpires, after investigation, that the report is incorrect. The actual facts are that some cracks developed in the cylinders of one of the auxiliary engines, but the vessel proceeded on her voyage and the small engine continued its operation regardless of the cracks.

Referring to the maiden voyage of the double-acting motorship SWANLEY outlined on page 666 of our September issue, we have been advised that at Cardiff on the 31st of June this vessel loaded 8,400 tons of coal, and averaged a speed of 10 knots on a daily consumption of just over 6 tons of fuel-oil to Columbia. At the latter port, she discharged and sailed for Calcutta on August 18th, arriving on the 25th. She then loaded 8,800 tons of coal for Bombay and sailed on the 29th.

On August 25th, the 8,400 tons d.w. single-screw motorship SILVERLARCH ran a

successful trial trip off the mouth of the River Tyne. She was built by Swan, Hunter & Wigham Richardson, Ltd., Wallsend, and is propelled by twin six-cylinder Neptune two-cycle oil-engine of 2,000 s.h.p. The SILVERLARCH is 400 ft. long by 55 ft. 3 in. breadth and 28 ft. 8 in. depth. She is one of the fleet for the Roosevelt Steamship Co. of New York. She arrived at New York on her maiden voyage during the middle of September.

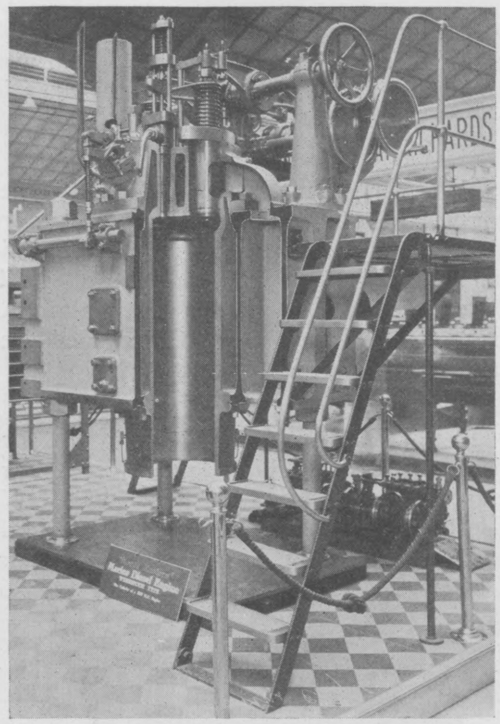
According to reports, the wooden motorship OREGON, of the Independent Steamship Co., Seattle, gave excellent results on her recent maiden voyage covering Southeastern Alaska ports as far as Juneau. On her return voyage she had a full cargo consisting of canned salmon and herring oil in her tanks, and 80,000 ft. of spruce lumber. This vessel was recently equipped with twin 500 s.h.p. McIntosh & Seymour Diesel engines. Evidently the days of the wooden ships are not over, provided they have the right type of propelling mechanism.

Referring to the motortanker BRITISH AVIATOR, propelled by single-cylinder Palmer-Fullagar Diesel engines, the latter developed 3,720 i.h.p., or 2,950 s.h.p. on her sea trials, at 82.5 r.p.m., driving the vessel at 11.7 knots. The fuel consumption was 0.408 lb. per s.h.p. hour, using Anglo-Persion Diesel oil of 18,900 B.T.U. While centrifugal fuel-oil purifiers were installed, they were not in operation when the foregoing results were obtained. Exhaust gases were passed through a donkey-boiler and pressure of steam of 9 lbs. was raised.

The three motor passenger-vessels to be built for the Osaka Shosen Kaisha of Osaka, Japan, referred to on page 675 of our September issue, will operate between the Orient and the Puget Sound. Length, 430 ft. by 56 ft. breadth and 38 ft. depth. Accommodation will be provided for 40 cabin and 780 steerage passengers, and the first vessel will be ready at the end of 1925. As stated, twin 2,300 s.h.p. Sulzer and Mitsubishi-Sulzer Diesel engines are now being installed in these boats. We will again repeat that Japanese motorships will form formidable competitors on the Pacific Coast for steamships of our leading Pacific Coast steamship lines who have not yet turned to Diesel power.

Oil Engines at British Empire Exhibit

Outstanding among the marine exhibits shown at the Wembly Empire Exposition are those of Swan, Hunter & Wigham Richardson and of the North Eastern Marine Engineering Works. Illustrated on this page is the Swan, Hunter stand, devoted entirely to models, cut-away sections and actual working parts, both of the Neptune and of the North British engines. Unfortunately, the photograph of this exhibit was taken from such an angle that the large



N. E. Werkspoor integral-cast cylinder-head and liner are clearly shown by the cut-away

double-trunk piston used by the last-named firm for their two-cycle double-acting engine is obscured by the two columns of the enclosure. The object visible to the right-hand side of one of the columns is not a piston, but one of the cylinder heads or plugs on which the sliding cylinder moves back and forth. On the left-hand side of this exhibit is a cut-away section of the Neptune two-cycle single-acting piston and cylinder and although here again the photograph was not taken from the best possible angle, the more striking characteristics of the new Neptune construction may still be observed.

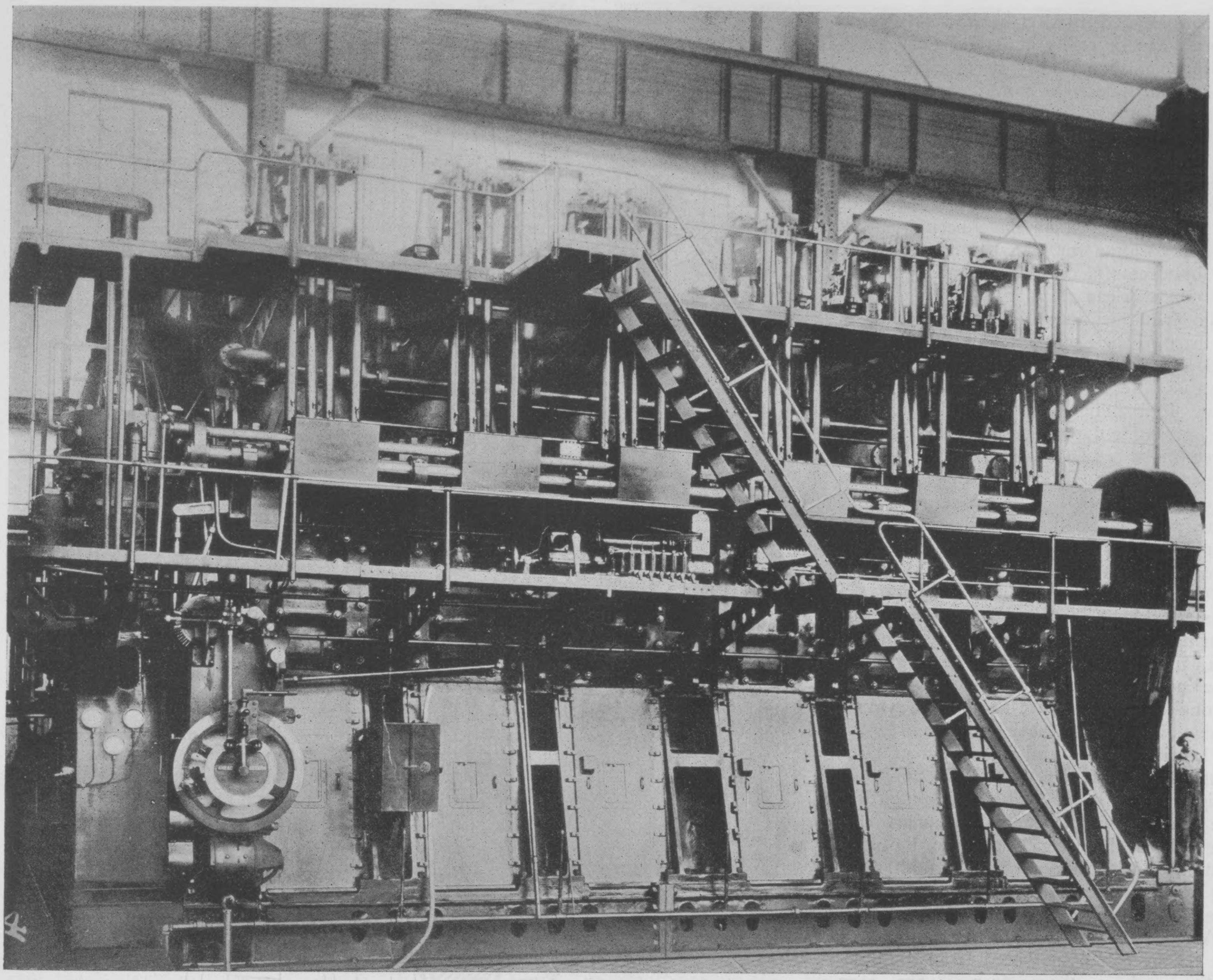
The North Eastern exhibit is a most striking one, consisting as it does of an unusually large single-acting cylinder such as is used in actual practise with a quarter of the cylinder walls and jackets neatly milled away in such a manner as to give an unusually striking view of the inner parts and construction of this make of engine. It is hardly necessary to point out that this is the characteristic Werkspoor design, built under license by the North Eastern Company.

A clear view is afforded of the cast-in-one cylinder head and liner, also of the return flange by means of which it is fastened to the cylinder box. The latter is seen to be massive and deep, well capable of resisting not only the working strains of the engine, but of the ship's hull as well. The Werkspoor Company are the originators of this construction, having used with success on the first large ocean-going motor tanker which ever sailed the Atlantic. This was the *Juno,* commissioned early in 1912.

Another Standard Oil Motorship

A new tanker is to be built by the Bethlehem Building Co., San Francisco, for the Standard Oil Co. of California, for their Trans-Pacific service, between the Hawaiian Islands and the U. S. A. Twin 400 s.h.p.

Cut-away sections of actual parts used on marine Diesel engines make the Wembley Exposition graphic and interesting

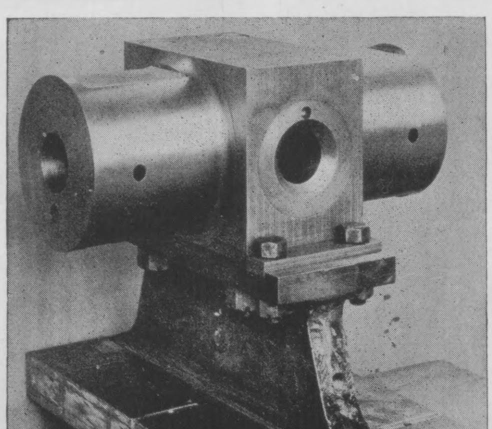


An American 2,600 i.h.p. Four-Cycle Marine Engine

Latest Diesel Model Brought Out by the McIntosh & Seymour Corporation Does Not Differ Radically From Their Previous Design, But Incorporates Modern Improvements

UNLESS future development of other types or alternative systems of oil-engine drive reduces construction costs to a marked degree, there is likely to be a steady demand for slow-speed, single-acting, four-cylinder Diesel engines for new cargo motorship propulsion for a decade to come. Many shipping men, not without ample justification, have implicit confidence in the splendid service given by many good designs of propelling plants of this class, regarding the same as being akin to the hundred-years old reciprocating steam-engine. To such shipowners the questions of lighter weight and shorter length will carry but little argument of a persuasive nature. Twelve years successful operation of sea-going Diesels have produced such remarkable results on the black ink side of shipowners' books, that these reliable units can hardly be perfunctorily cast to one side when the subject of new tonnage comes before the directors.

The McIntosh & Seymour Corporation recently completed a large marine engine of 2,600 Indicated Horsepower for marine work, and a brief preliminary description was published in MOTORSHIP some months ago. We are now enabled to give complete details.



Crosshead and slipper

This engine is of the vertical, single acting, four-cycle, crosshead type and is directly reversible. There are six working cylinders, each of 30″ bore and 48″ stroke, and at a speed of 115 R.P.M. gives a rated shaft horsepower of 1915. It is provided with a compressor of the three-stage type and is mounted on the forward end of the engine, while at the aft end is mounted a thrust-bearing of the single-collar type.

According to the usual practice of this corporation, the entire engine is built to comply with the rules and regulations laid down by the various Classification Societies operating in this country; principal of which are the American Bureau of Shipping and Lloyds' Register of Shipping. The scantlings of the various parts, therefore, are such that they come within the rules of either society, so that it is only a matter of arranging for physical tests, for these engines to be built directly under either societies' rules.

Since the total weight of this engine is approximately 318 tons, it has a weight per indicated horsepower of 245 pounds. It

is so designed that right and left hand models can be easily built and twin screw arrangements can easily be taken care of. In both left and right hand installations the maneuvering gear is located at the forward end of the engine and is electrically operated.

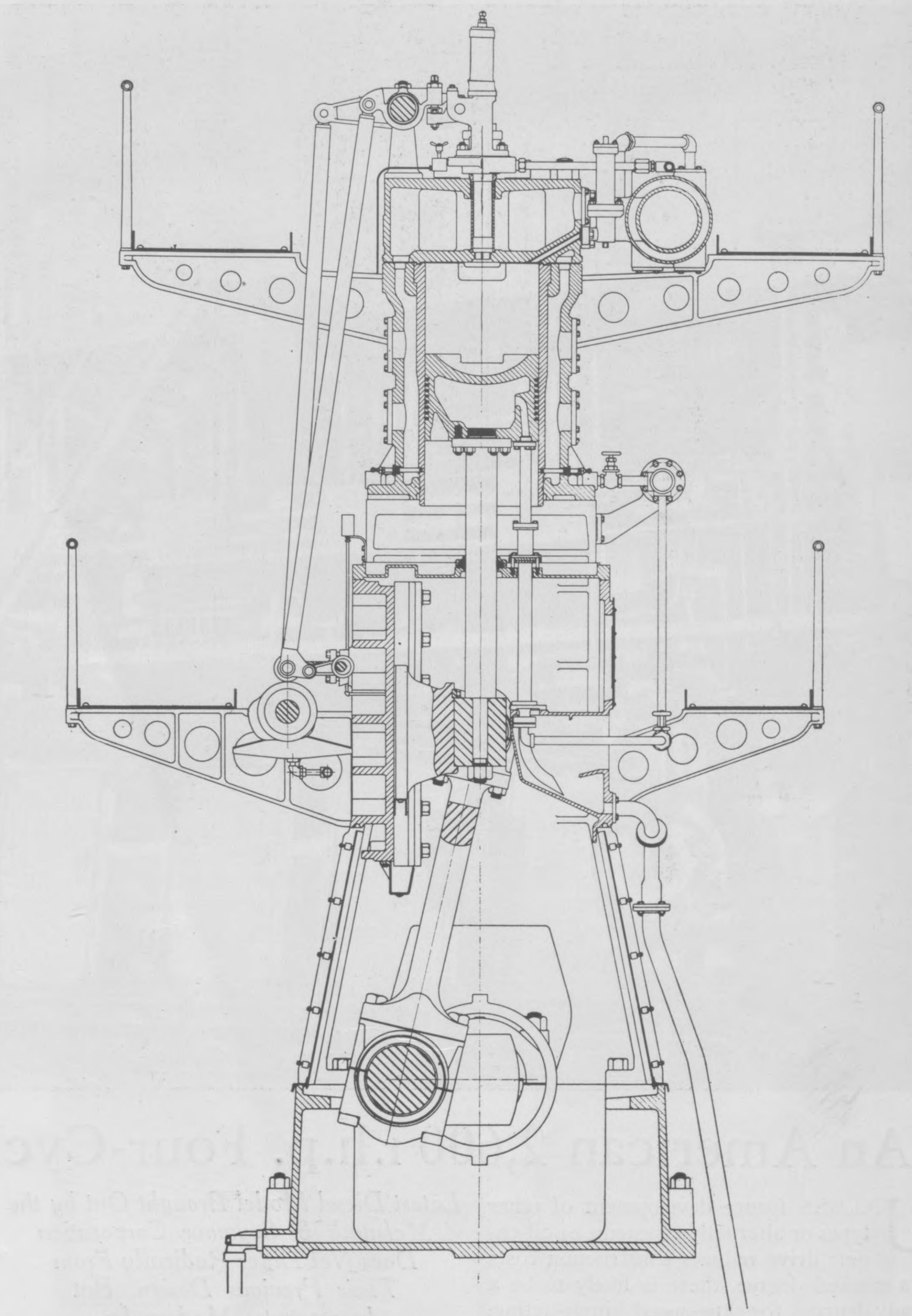
The general arrangement of the engine follows closely that of the smaller types of marine engines which have been built by this corporation for many years and which are in successful operation in a large number of American ships.

To facilitate manufacture and erecting, the base of the engine is made in two parts and bolted together at approximately the center. The forward half is arranged to carry four main bearings and the compressor, while the after half takes the other three main bearings and the single-collar thrust bearing. Special arrangements are provided to keep the two bedplate sections exactly in line so there can be no possible trouble arising from this cause due to any "working" of the ship.

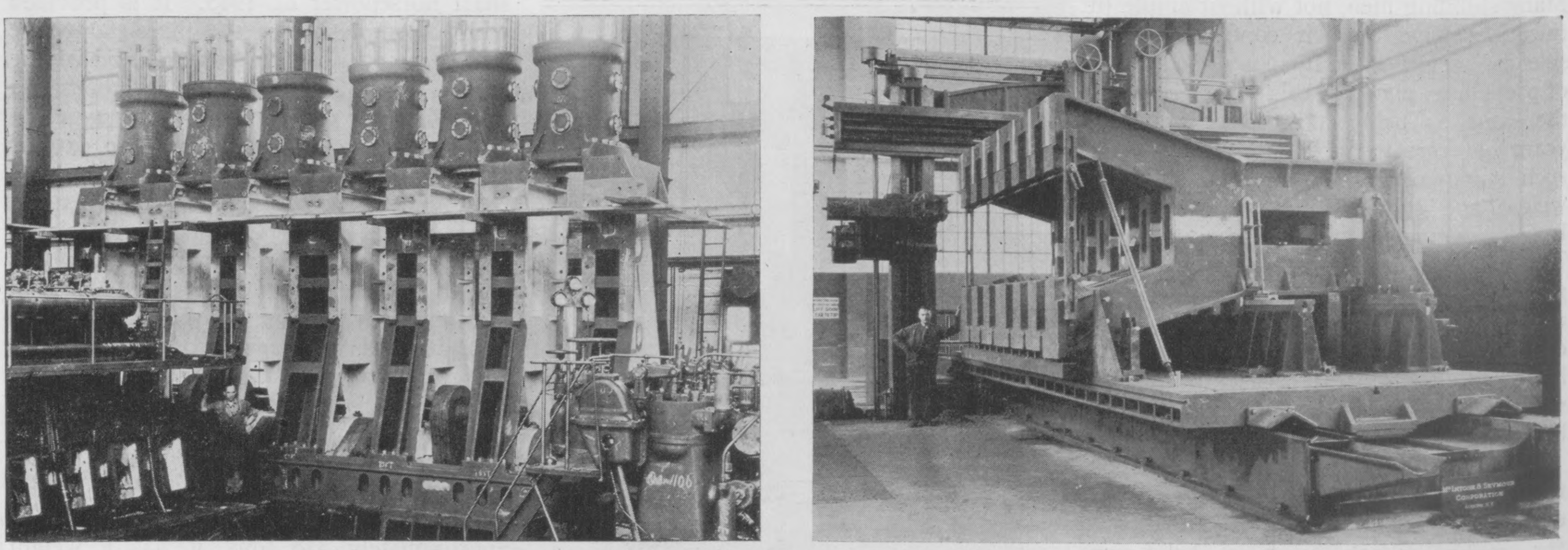
Although the bolting for attaching the frames is kept as close as possible to the bearings, this does not interfere with convenient access to the main bearing caps. The arrangement, which is carried out throughout all the McIntosh & Seymour designs, makes them have a minimum length of bearing girder, and insures great stiffness as well as strength with minimum weight. The ends of the bearing girders are carried by longitudinal members cast integrally with the enclosed base, the solid bottom and longitudinal members all making a base of great stiffness and longitudinal strength.

An idea of the sizes and construction of the frames can be gathered from the illustration, where these frames are seen mounted on the planer in the process of machining.

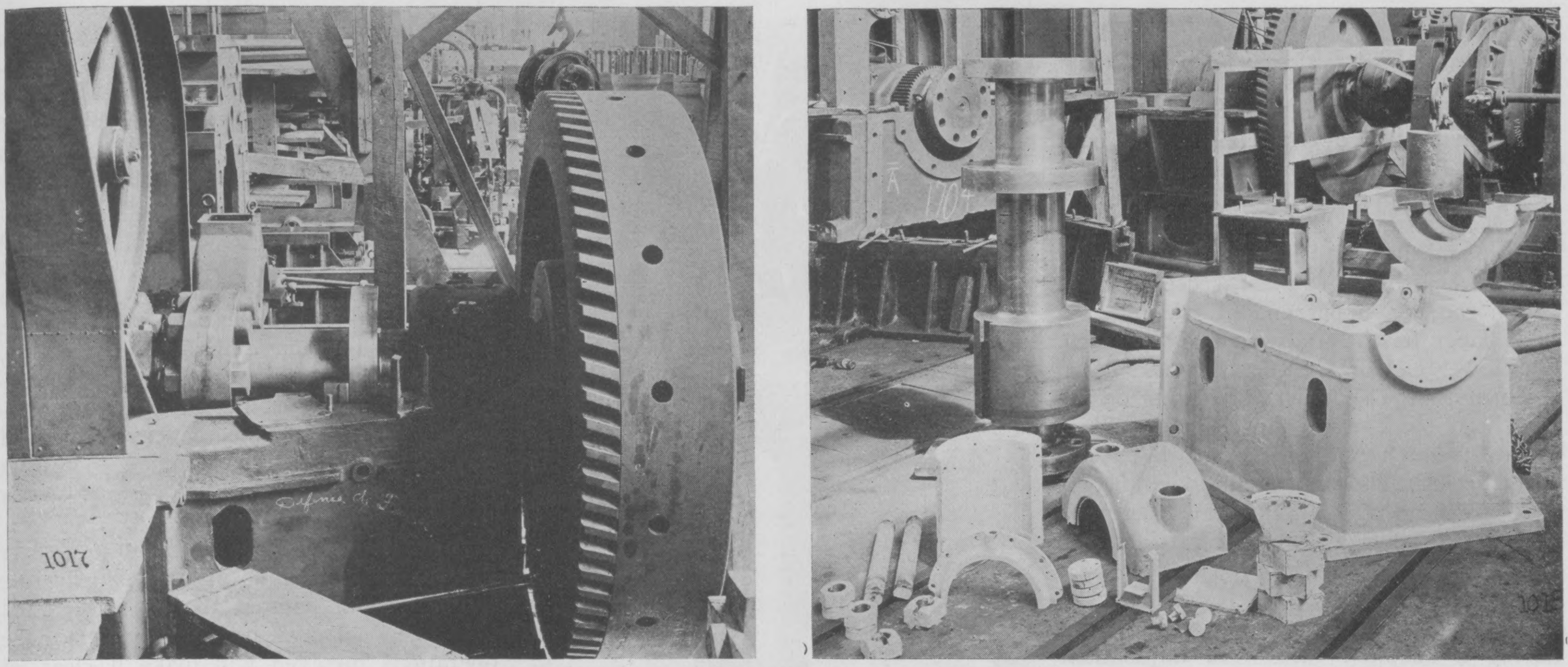
Although of substantial design these frames have at the same time been reduced in weight without interfering with the strength of the structure. They are arranged for the mounting of the cylinders on their upper ends and to carry the principal stresses from the cylinders, to the base in the most direct manner possible.



Large McIntosh & Seymour engine of the same general type that develops 2,600 i.h.p.



Frame construction of McIntosh & Seymour engine is clearly shown by these illustrations. The "A's" straddle the main bearings, and as the tops of the frames are connected together by massive plates, a rigid bog-girder is formed by them



A thrust bearing of the single-collar type is built into the engine. Its component parts are clearly shown at the right

Longitudinal bending stresses throughout the machine are completely taken care of because of the box-structure resulting from the interconnecting members secured between the frames. One side the box is formed by the crosshead guide plates and the other side is made up of stout panels on which the piston cooling gear is mounted. Whereas the crosshead side is completely closed off, access is provided from the other side through apertures of ample size.

Substantial sheet metal covers are provided over the crank openings and are fitted with sliding doors to give convenient access for inspection while the engine is in operation without any chance for throwing lubricating oil on the gratings.

The cylinder head is made of a deep cylindrical section, cast in semi-steel giving strength and stiffness with the minimum metal thickness. Since the bottom of the head consists of a member having only the diameter of the liner fit, large openings corresponding with those in the cylinder jacket are left between the studs, thus providing for ample jacket spaces and the fullest possible flow of the cooling water. Moderate heat conditions due to the prompt combustion of the fuel, and the special material mentioned have combined to give this head extremely long life in service.

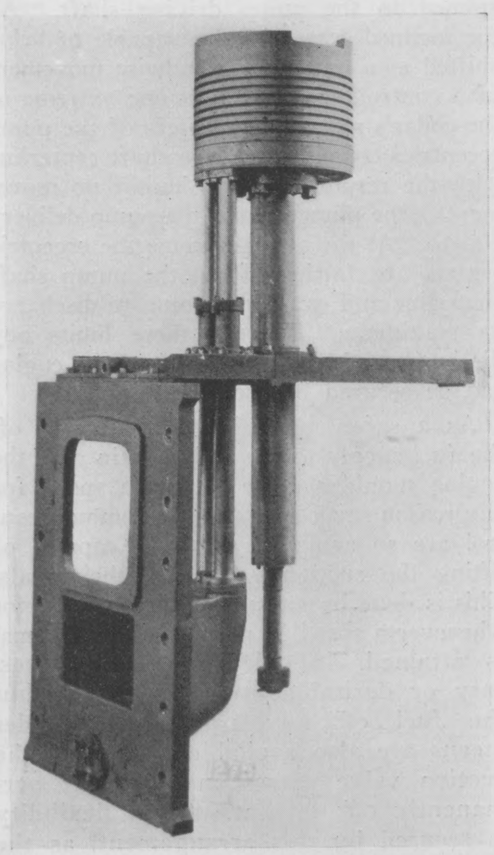
Each head is fitted with suction, exhaust, starting air and fuel valves. The suction and exhaust valves are interchangeable and have heads of cast iron fused to a steel stem. These are fitted into renewable cages which are also interchangeable and with springs of such length as to give the maximum life.

The fuel valve, which is considered by some to be the most important part of a Diesel engine, is made by the corporation under the Hesselman patents. It is fitted with the Hesselman pulverizer, one of the most effective means so far devised for the preparation of the fuel for burning in a Diesel engine cylinder. This pulverizer gives maximum efficiency with prompt and complete combustion and does not need to be varied with the different grades of fuel that are met with from time to time.

It is of course a well known fact that where separate pulverizer cones and plates are used in connection with fuel spray valves the grooves in the cones and the holes in the plates or the number of plates fitted are varied to meet the varying conditions of the fuels from time to time.

The Hesselman pulverizer is immune against these varying conditions, having the same characteristics for heavy Texas "C" boiler oil as for the lighter oils of approximately 30 to 32 degrees Beaumé gravity.

Cylinder jackets of ample section transmit the working leads to the main frames through stout flanged connections, as is clearly shown in the illustration. Inside the jacket is fitted a renewable liner cast of a special mixture of charcoal iron, which is claimed by the manufacturer to possess superior wearing qualities. Although secured at its upper end with a force fit, its lower end is unconstrained and free to expand as load and temperature conditions demand.



The stationary tubes of the piston-cooling set are rigidly held on framing-plate

Ample openings between the cylinder studs are arranged to allow for the free circulation of the cooling water at the hottest part of the cylinder and hand holes are provided on the outside of the jacket to give convenient access to the jacket space for cleaning purposes.

Since this engine is of the crosshead type, the pistons are no longer than is necessary to carry the piston rings and are securely bolted to a flange at the top end of the piston rod and arranged for water cooling. They are cast in dry sand and are of a special charcoal iron mixture very similar to the mixture used in the cylinder liners. Accurate machining is a special feature in connection with their manufacture, and the number of rings fitted are only such as is necessary to give the satisfactory service demanded of a marine piston.

The illustration shows one of these pistons mounted complete with the piston cooling arrangement on one of the tie plates which are fitted between the A-frames. As will be seen, one set of cooling pipes is fastened securely to the under side of the piston, while the other set is bolted rigidly to the tie plate, and the arrangement is such that there are no joints on the inside which would allow the cooling water to mix with the ordinary lubricating oil.

The telescopic joints in this arrangement are not supposed to be absolutely tight, and any leakage taking place near the piston is provided for and caught by the diaphragm shown, which is provided with a stuffing box for the piston rod.

Such leaking as may take place at the lower end runs into the recess in the diaphragm plate and passes with the overflow water into the bilges. It might be

mentioned, however, that every precaution is taken to avoid any leakage taking place in these telescopic pipes, and instead of the usual double pipe arrangement being used a special system of triple pipes has been designed for this purpose. In actual service this has proved to be completely effective and well worth the extra trouble of manufacture and fitting.

Open hearth forged steel is used for the piston rod, the upper end of which has a wide flange for the attachment of the piston. The lower end of the rod is turned down to form a large shoulder for resting on the crosshead block while the reduced portion passes through and is secured by a nut specially locked to prevent its loosening.

A crosshead which is illustrated herewith is of the ordinary standard marine type with the pins forged in one with the body. This crosshead is securely fastened to the slipper which is made from a steel casting having a babbited face. An adjustment for wear is provided for by liners between the slipper and the crosshead.

Guides for the slipper consisting of cast iron and carefully machined are arranged to be mounted between the frames on the opposite side to the tie plates carrying the piston cooling arrangement. These guides are of the usual marine design and are carefully finished to receive the babbitted slipper already mentioned.

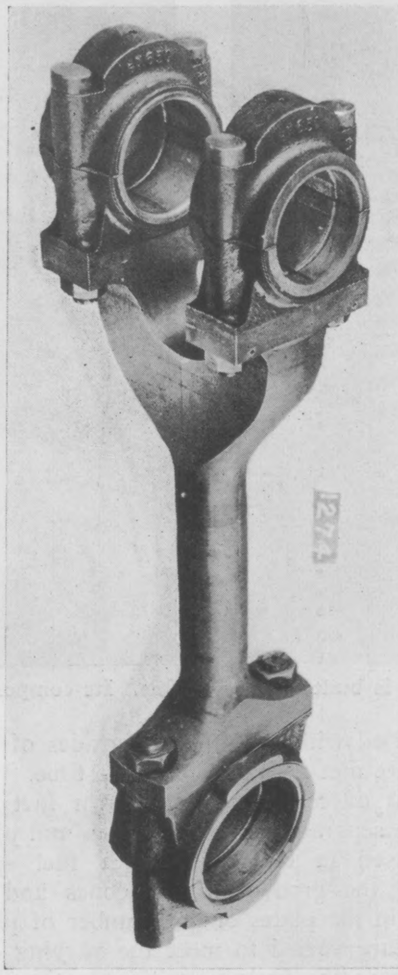
The connecting rod, which is also illustrated has a body of forged steel and carries bearing boxes of cast steel lined with white metal. It is of the usual marine construction and of substantial design, and is eminently suitable for the work which it is called upon to perform.

The crank shaft is made in two sections, each one being built up from separate web and crank-pin forgings. The two halves are convenient for handling and bolting together at the center. At the forward end is fitted an over-hung crank for driving the compressor, and at the aft end the cam shaft driving gear is mounted. All such shafts as these are made to conform with the requirements of the Classification Societies whether called for under the customer's specification or not.

Spur gearing is used to drive the camshaft, a train of five wheels comprising two active and three idler gears being employed. They are made of cast iron with broad faces and as their outlines are cut to a special shape, they are endowed with maximum root strength and have a long life.

Located half-way up on the engines is the camshaft, which runs the entire length and carries the double sets of ahead and astern cams. Reversal of the engine is effected by an endwise shift of the cams, as the result of which either the ahead or the astern group is brought into operation. The reversing motion of the shaft is derived from the electrically controlled maneuvering gear.

Motion is imparted to the valve stems through the medium of cast-steel valve rockers mounted on a fulcrum shaft and provided with the usual hardened steel ad-



Connecting rod is made of forged and cast-steel throughout

justing screws for setting the working clearances.

A fuel pump having an individual plunger for each cylinder is provided according to generally current practice. Each plunger has its own eccentric, which, in turn, is mounted on a second inclined eccentric splined to the pump driving shaft. All the inclined eccentrics are capable of being shifted as a unit by the endwise movement of a controlling collar. At one extreme of the collar's motion the centers of the pump eccentrics coincide with the shaft centerline with the result that they impart no movement to the plungers and the pump delivery is zero. At the other extreme the eccentric centers are farthest from the pump shaft centerline and cause the pump to discharge its maximum. Between these limits any discharge and hence any load on the engine can be secured by the operator.

As a safety provision for shutting off the fuel supply to the cylinders in case the engine should acquire excessive speed for any reason small levers under common control are so arranged as to be capable of lifting the suction valves off their seats. This is done by means of a small governor whenever a speed 10 per cent above normal is attained. Should it become necessary or desirable at any time to shut the fuel off any particular cylinder means are also available for lifting the suction valve corresponding to it permanently off its seat. Great flexibility is secured by this arrangement, as the result of which the operator is given complete freedom of choice as to the cylinder or cylinders on which he wants the engine to fire.

A most favorable impression was made upon recent visitors at the Auburn plant of the McIntosh & Seymour Corporation by a demonstration of the electrical reversing and maneuvering gear in this engine. As the result of the design which has been adopted, the work of answering bells which must be done by the engineer on watch has been reduced to the most amazing simplicity. In the course of the demonstration, a young lady from the stenographic department of the McIntosh & Seymour Corporation was called on the maneuvering stand and was able to start the engine, to reverse it, and to make it run at various speeds without assistance of any kind.

Although it would be difficult to explain the mechanical details of this maneuvering gear in detail without the use of lettered cross-sectional drawings, a summary of the operations involved will make it clear, at least to those who have seen the engine, how the maneuvering is accomplished. Those who are familiar with the standard hand reversing mechanism used on McIntosh & Seymour engines of smaller power will have no difficulty in understanding the controls of the 2600 h.p. engine because they consist essentially of those which have always been used with the addition of an electric motor to relieve the operator of the heavy cranking required on a big engine.

It may be noted in passing that the use of electric current for maneuvering the engine is thoroughly in line with the most modern motorship practice. So great a dependance is placed on electric power for the operation of vital auxiliaries on modern motorships that the extension of this principle to the maneuvering system is only logical. Not only could it be impossible to operate the ship without current, but every precaution has also been taken to insure that the failure of current is practically ruled out.

Although the reversing gear consists essentially of three members attached respectively to the mechanism for end-wise displacement of the cam shaft, for withdrawing the ends of the push-rods from engagement with the cams, and for maneuvering the delivery of the fuel pump, all of these functions are united in but a single lever which needs to be operated by hand. As this consists essentially of a crank moving over a circular wheel or dial (plainly shown in the illustration), there is very little chance for error in manipulating it. Moving it to one side causes the positioning of the cam shaft for a head motion, whereas its displacement to the other side results in reversing the engine. It makes the necessary electrical contracts for starting and stopping the electric motor and is accompanied by a follow-up member which shuts off the current as soon as the hand crank has been put in the proper position and the rest of the mechanism has gone through the motions called for by it.

For controlling the delivery of the fuel pump with a view to altering the speed of the engine from dead-slow to full speed,

small electrical push buttons are used. As has been stated, these maneuvers, although somewhat awkward to describe without suitable graphical material, are in realty so simple that the little slip of a stenographer was able to carry them out with less effort that it takes her to run her typewriter.

British Shipbuilder Visits America

Sir Alfred Yarrow of the well-known shipbuilding firm of similar name, with yards at Vancouver, B. C., and Glasgow, Scotland, recently arrived back in England after a visit to the United States and Canada. To two of the representatives of the Liverpool JOURNAL OF COMMERCE who interviewed him on his arrival, he stated that Diesel engines have induced many shipowners to place new motorship orders who would not have thought of ordering steamers under the present slackness and trade slump. "It is," he said, "much more economical to run a vessel with Diesel engines than one whose motive power is derived from steam."

Board Will Open Diesel Bids On Oct. 14

On representations made by a committee of the Atlantic Coast Shipbuilders' Association that a material saving might be possible, amounting perhaps to as much as 20 per cent in the total cost, by allowing a shipyard to bid o nthe total conversion job including main engines and auxiliaries and the installation thereof, it has been decided to allow those shipyards who are also Diesel engine builders to submit an alternative proposition on this basis. In order to permit them to do this it has been found necessary to delay the opening of the bids on the initial work of the Diesel engine program until noon, October 14th.

In thus extending the time for opening bids it was clearly explained that the bid on the complete installation should be an alternative bid and the Government still desired to obtain bids on the engines proper, as per the original proposals, in addition to this alternative bid on the installation as a whole. It was further explained that the Government must reserve the right to withhold award on the bid for the installation as a whole until such time as it will be possible to obtain separate prices for the auxiliaries and the installation in accordance with the original program. Only in this way will it be possible to determine definitely the extent of the saving that might be found possible by considering the award on the basis of the installation as a whole.

In order to be fair to the reliable and experienced firms and to obtain the advantages of their engineering experience and at the same time obtain for the Government the advantages of maximum competition, it is the desire of the Fleet Corporation officials to allow qualified engine builders to bid on auxiliaries, and qualified shipyards to bid on installation.

Emergency Standby Power for Ships

Self-Contained Internal-Combustion Engines Are Required

Motorization of ships' auxiliary and standby machinery has many advantages, not only for motorships, but also for steam vessels as well. Whereas it is possible to use steam for those auxiliaries which are required for normal operation, emergency standbys cannot well be steam driven. They must be capable of being placed in service almost instantly if they are to be of any value and they must be self-contained as well as completely independent of all the other machinery, piping systems, etc., found on the ship.

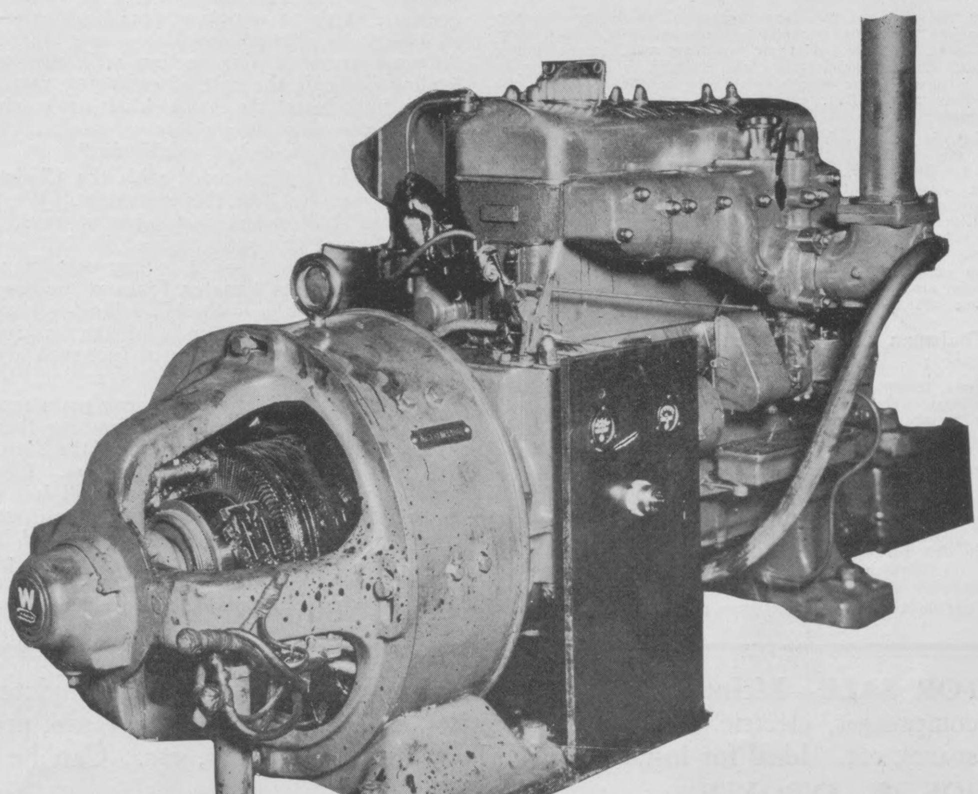
Be it a ship or a building, the first thing that generally happens in case of fire or other emergency is that the lights go out because of disturbance of some part of the wiring or of the generating machinery. In many cases great damage has been caused and loss of life ensued not because of the original accident—which may have been trifling in itself—but because of the failure of electric current. Panics caused in crowded theatres by darkness alone have cost thousands of lives and sea disasters have been caused by the failure of current desperately needed for lighting and for radio communication.

Only recently passengers on the liner BOSTON had a taste of this sort of thing when she was rammed by a tanker. Although not actually exposed to the danger of sinking, the men, women, and children on this ship had to suffer agonies of uncertainty as the result of being placed in total darkness by the crash. Had there been an internal-combustion emergency lighting set installed on this ship lights could have been restored within a few minutes after the accident and the passengers greatly calmed and reassured thereby. Instead of carrying away with them memories of darkness and terror, the incident would have been remembered by them as hardly more than one of the inevitable inconveniences encountered by travellers every now and then. The amount of patronage saved for the steamship company would probably have paid for equipping their entire fleet with emergency generating sets.

Even cargo-vessels are frequently supplied with such sets, perhaps the most notable of these being the BENSON FORD and the HENRY FORD II, fully described in September MOTORSHIP. The units employed on these ships for emergencies consist of a four-cylinder Hall-Scott engine direct connected to an 18-kw. Westinghouse d.c. generator. Based on the long experience of the Hall-Scott Motor Car Company in the manufacture of automotive and aeroplane engines, the motors used for these generating sets give every indication of being a highly finished product. They are completely self-contained and meet the requirements of an emergency standby in every possible respect.

Equipment on Ford Motorships

Among equipment on the motorship BENSON FORD, which was referred to in our article last month, may be mentioned several Chas. Cory products, namely the whistle-control system, electric engine-order telegraphs, anti-noise telephones, which were made under Magnavox patents.



A Hall-Scott stand-by generating set suitable for emergency use on all types of vessels

Are Government Loans for Steamship Construction Within the Law?

Since the Merchant Marine Act of 1920 authorizing the Shipping Board to loan money to private interests for the construction of ships "provided such vessels are equipped with the most modern, the most efficient and most economical machinery," the question has been raised in some quarters whether the Board is acting within the law making loans from this fund for steamship construction in cases where the vessels to be built come within the present limits of Diesel-engine power.

In order to put this topic forward for discussion and to ascertain the Board's attitude and policy MOTORSHIP addressed the following letter to Chairman O'Connor on June 27th.

We are informed that resolutions have just been passed by the Shipping Board making available large loans for the construction of *steam-driven* vessels. The Loan Section of the Merchant Marine Act, however, includes the following clause:

"The Board may use such fund to the extent that is proper . . . provided such vessels shall be fitted and equipped with the most modern, the most efficient and the most economical engines, machinery and commercial appliances."

We beg to inquire, in view of the specific limitations above placed upon the purpose of money loaned and the type of machinery to be installed, whether the Board considers that a loan can legally be made for steam propelled vessel construction of the type proposed by the Coamo Steamship Corporation, a subsidiary of the New York & Porto Rico S.S. Line.

According to published information this vessel is a combination passenger-and-cargo liner of the following dimensons:

Deadweight capacity	5,000 tons
Shaft horsepower	6,500
Length	428 ft.
Speed	16 knots
Passenger accomodation	300

We desire to point out that this vessel comes within the dimensions, tonnage and power of many motorships in successful operation for many years in Europe, which have definitely proven that the heavy-oil burning internal-combustion engine (or Diesel) form of propulsion is more modern, more efficient and more economical than steam drive. We enclose photographs of several examples of such combination passenger-cargo motorships.

We call attention to the fact that this is well supported by the Board's own contention, outlined by yourself in the *Daily Press*, that the proposed two Diesel motor-liners for the United States Lines will be the most modern, and the most economical, etc., passenger ships afloat. Also to the resolution of the Shipping Board granting the loan for the aforementioned *steamship* to be built under the Merchant Marine Act, which Act makes it compulsory to equip vessels built with such loans with the most modern engine-room and deck machinery. Is there not a very apparent conflict?

Furthermore, is it not contrary to the spirit of Section 11 of the Merchant Marine Act (which is intended to aid in modernizing the American Merchant Marine and rendering American ships equal to or better than those of our foreign competitors) to loan such money for comparatively uneconomical and less modern *steamships* in cases where such craft are within the limits of motorships now successfully operated by our competitors on the high seas?

In the case of the large steam-driven liners for the Cherokee Seminole Steamship Corporation the loan may be legal, because of their tonnage and power being greater than Diesel-driven craft actually in service, making it possible for such steamers to be the most modern of their type. But, even here, is there not room for question?

But, is it not obvious that the money to be loaned for the New York and Porto Rico Line ships and for the Robert E. Lee Steamship Corporation will produce vessels that, except for minor details, will be of no advance over similar ships constructed years ago, thus preventing them from being "of the most modern, the most efficient and the most economical type," which words were especially introduced in the Act by Congress expressly to prevent other than absolutely modern vessels and very latest examples of the marine engineering art from being built.

Chairman O'Connor's reply dated July 11th as follows:

Your letter of the 27th ult. was duly received and has been given very careful consideration.

It is unnecessary to remind you of the very great interest this Board has been and is taking in extending the use of internal combustion engines. The recent action of Congress in amending the Merchant Marine Act, 1920, so as to allow loans from the Construction Loan Fund to be used for installing internal combustion engines in vessels already built, and also authorizing the Board to use as much as $25,000,000 in similar equipment for vessels of its own fleet, is due chiefly to the initiative and activity of the Board, and is an illustration of its zeal in the matter.

Your letter takes an extreme postion which we think is not justified; it at least implies that turbo-electric propulsive machinery, if used in a vessel of a size in which an internal combustion engine could properly be used, is not of the "most modern, the most efficient and most economical type of machinery" for such vessel.

We do not think this would be a proper interpretation of the Act of Congress. That act does not, in our judgment, limit the Board to a type of engine which may, in the opinion of some experts, be the most advanced type; to impose such a limitation might in some instances limit the use of the fund to machinery which, in the opinion of other experts, is in an experimental stage.

This is a period of transition for marine engines, and the Board wishes to do justice to the several types which are in competition. It wishes to encourage the use of the most advanced types; but it is unwilling to unduly coerce owners in the selection of propulsive machinery, provided the type selected may be reasonably classified as "of the most modern, the most efficient and the most economical" kind.

We appreciate your interest in the matter and we will welcome your suggestions at all times in relation to any matters coming within the jurisdiction of the Board.

Very respectfully yours,
T. V. O'CONNOR,
Chairman.

This journal believes that the Shipping Board as now constituted is giving fair and earnest consideration to the part which the Diesel engine can play in the rehabilitation of our merchant marine. It is true that the Board has failed signally to show promptness in decision and action, but these are the characteristic deficiencies of government administration and we think we discern in the Board's present program a genuine desire to encourage the use of motorships by American owners, a course which we heartily endorse.

In the light of this situation we have no desire to be unduly critical where the Board's course of action is concerned but a dispassionate consideration of the letter of the Merchant Marine Act in the light of the present status of the Diesel engine as a marine propulsive unit would indicate that, in spite of Chairman O'Connor's interpretation of the law, reasonable doubt *does* exist as to the legality of some of the steamer loans now being made by the Board.

It is the opinion of well informed students of the situation that if some ardent champion of motorshipping, acting as a tax payer, was to challenge the Boards action in the courts, difficulty might be experienced in justifying some of the latest loans in the light of the law.

That, within the limits in which they have been tested, Diesel engines conform strictly to the mandate of Congress which requires the ultimate in moderness, efficiency and economy, has been testified to by the Board itself on other occasions.

In a press release given out June 16th, Chairman O'Connor himself said:

"Section 11 originally provided for a 'Construction Loan Fund' * * * to be loaned at a nominal rate to nationals for the construction in domestic yards of vessels equipped with the *most modern and efficient machinery and appliances.* As now amended this section will also permit lending one half the cost of equipping vessels already built with the same kind of machinery which *in reality means internal-combustion engines and electric-driven auxiliaries.*"

We are in entire accord with the Chairman's views as set forth in this statement. We think the Jones' bill means just what it says. The phraseology of this paragraph of the bill we view with a certain pride as it is our own langauge, submitted by us to Senator Jones at the time and incorporated by him in the bill following his characteristically thorough study of the basic facts, which confirmed the wisdom of just such a stipulation.

No piece of legislation in recent years received more study and thought in its framing than the Jones' Bill which is a monument to the thoroughness of the man whose name it bears. Like the prohibition amendment the Jones' Bill has never had a fair trial because it has never been put into effect; a situation which must be ascribed in the main to the unconscious tendency of the executive branch of our government to usurp the function of both the legislative and judicial branches.

Valuable German Book in English

Printed in English on good paper and illustrated with a wealth of excellent cuts and clear illustrations is a collection of reprints from the Diesel Engine Congress held in Berlin during July, 1923.

Thoroughness, as every one knows, characterizes most German undertakings and the discussions which were held at the above mentioned congress, as well as the official reports of them more than bear out this view. In the first section a comprehensive survey is made of the leading Diesel engine developments that have taken place in Germany. So voluminous and so highly condensed is this material that it would lead us far beyond the scope of this review to list it. Line drawings of stereoscopic clearness cover page after page and the accompanying English text discussess them in an analytical yet thoroughly readable manner.

This collection of seven authoritative articles covering more than 70 pages 8¾ inches by 12¼ inches and bound between substantial paper board covers, is obtainable from MOTORSHIP Technical Book Department at $2.25 per copy plus postage.

Motorship

New York Seattle San Francisco

CONVERSION SECTION

OCTOBER, 1924

Published in Two Sections SECTION II

Conversion **Motorship** Section

(Trade Mark Registered)

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Section II

America's Opportunity, Once Lost, May Be Regained

OF ALL the trying problems left in the wake of war none have proved more intricate and vexatious than that of how to dispose of our emergency fleet so as to conserve its intrinsic value, and at the same time best serve the national welfare now and in the future. The magnitude of this task is reflected in the ever-changing personnel of the Shipping Board, a kaleidoscope which has brought the minds of many men, some of marked ability, to bear upon this problem, with little success. Various proposals have been made, ranging from scuttling the fleet to making shipping a government monopoly, but in the main the policy governing the Board since the war has been one of slow, cautious liquidation, very rarely illuminated with the spirit that won public support when the fight was on.

It is a curiously interesting fact that every man who has held the position of chairman of the Shipping Board, from William Denman to Albert Lasker, has publicly advocated at one time or another the installation of Diesel oil engines in the Board's cargo-ships. But, like Mark Twain's famous quip about the weather, everyone has talked about it and no one has done anything.

During the war millions of dollars were squandered on dubious experiments such as jerry-built wooden steamers, concrete ships and other products of the hysteria of the time over which the charitable veil of silence has been drawn, but in the direction of motorships at least no excesses were committed. Conservatism ruled and, aside from installing imported oil engines in one vessel, nothing was done.

It is true that in the closing stages of the war some contracts were let for moderate powered Diesel engines to be installed, not in ordinary cargo carriers, but in trick submarine eluders. These contracts were speedily canceled when it became apparent that the war was over, and most of the engines completed under them were sold off as surplus material. It is not without significance that there was greater salvage value dollar for dollar in these Diesel engines than anything else the Board had to sell. Most of the engines we believe have gone into privately-owned ship operation and are giving satisfactory service today.

The answer to the question of why America built no motorships during the war would make an interesting chapter in itself. The Diesel engine was new in this country and had few active proponents aside from this publication; the Board's naval architect was a steam turbine enthusiast, and there were powerful interests on all sides who were not unwilling to see the United States saddled with out-of-date shipping. The inaction since the war is less easy to explain. The vigorous foreign program of motorship construction has left no doubt as to the competitive conditions which must be met in ocean shipping, and with everyone theoretically in favor of converting our emergency fleet the actual necessary steps have been put off on one ground or another from year to year.

The approach of the sixth anniversary of the armistice finds the Shipping Board finally engaged in formulating a policy for the application of a definite new statute empowering it to spend $25,000,000 directly on steam-to-motor conversions, and to loan to private shipowners upwards of $40,000,000 for the same purpose.

This journal does not believe that internal-combustion engines are a panacea for all the ills from which American shipping suffers, but when it is recalled that the finest body of merchant-men which ever spanned the seas—the Yankee clippers—went down to defeat before an armada of practical steamships it is well to reflect upon the futility of engaging in the world's most competitive business with obsolete facilities.

Whatever else we need to make our merchant marine successful in the form of wise laws and government aid to cover the spread between American and foreign living standards, we need also first and foremost an efficient and economical fleet—a fleet which will enjoy to the fullest degree the advantages of our great domestic storehouse of petroleum, and which will rank mechanically with the best that Europe can produce.

Whatever criticism there may be of the failure of the Shipping Board to have acted earlier in this matter, too much credit cannot be given to the men within the Board and in Congress who have kept up without ceasing the fight which finally secured the authorization of the present program. The bull-dog tenacity of Admiral Benson who has been a staunch advocate of the Diesel engine since he first took office is one thing which has kept the issue alive. Great praise is also due to Congressman Edmonds of Pennsylvania and his associates for their skill in forcing this issue through Congress in the face of unfavorable political conditions.

The success of the present movement will depend very largely on the extent to which private shipowners take advantage of the facilities of the new act. The Board will, of course, go forward with its own conversions but the stimulus of private initiative will be required to reap the full benefits of a broad program of conversions. American concerns must take over these ships and leave no excuse for further Government operation.

The purpose of this special Conversion Section of MOTORSHIP is to place in the hands of every American shipowner authoritative information of the most complete nature respecting the Board's Program; to gather and present the best available information concerning the terms under which federal aid will be extended for private conversions, and to set forth what has been accomplished in the private conversions already made, thus encouraging our owners to take the fullest possible advantage of the present unique opportunity to acquire at reasonable cost modern ocean carriers with the co-operation of the United States Government.

The Ship Conversion Act

An Act To Amend Sections 11 and 12 of the Merchant Marine Act, 1920

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 11 of the Merchant Marine Act, 1920, be, and the same is hereby, amended to read as follows:

"SEC., 11. (a). That during a period of five years from the enactment of this Act (Merchant Marine Act of 1920) the board may annually set aside out of the revenues from sales and operations a sum not exceeding $25,000,000, to be known as its construction loan fund. The board may use such fund to the extent it thinks proper, upon such terms as the board may prescribe, in making loans to aid persons citizens of the United States in the construction by them in private shipyards or navy yards of the United States of vessels of the best and most efficient type for the establishment or maintenance of service on lines deemed desirable or necessary by the board, provided such vessels shall be fitted and equipped with the most modern, the most efficient, and the most economical engines, machinery, and commercial appliances or, in the outfitting and equipment by them in private shipyards or navy yards of the United States of vessels already built, with engines, machinery, and commercial appliances of the type and kind mentioned.

"(b) The term 'vessel' or 'vessels,' where used in this section, shall be construed to mean a vessel or vessels to aid in whose construction or equipment a loan is made from the construction loan fund of the board. All such vessels shall be documented under the laws of the United States and shall remain documented under such laws for not less than five years from the date the loan is made; and, so long as there remains due the United States any principal or interest on account of such loan.

"(c) No loan shall be made for a longer time than fifteen years. If it is not to be repaid within two years from the date when the first advance on the loan is made by the board, the principal shall be payable in installments to be definitely prescribed in the instruments. Such installments shall be made payable at intervals not exceeding two years; and in amounts not less than 6 per centum of the original amount of the loan, if the installments are payable at intervals of one year or less; and in amounts not less than 12 per centum of the original amount of the loan, if the installments are at intervals exceeding one year in length. The loan may be paid at any time, on thirty days written notice to the board, with interest computed to date of payment.

"(d) All such loans shall bear interest at rates to be fixed by the board, payable not less frequently than annually. During any interest period in which the vessel is operated exclusively in coastwise trade, or is inactive, the rate of interest shall not be less than 5¼ per centum per annum. During any interest period in which the vessel is operated in foreign trade, the rate shall be not less than 4¼ per centum per annum. The board may prescribe rules for determining the amount of interest payable under the provisions of this paragraph.

"(e) No loan shall be for a greater sum than one-half the cost of the vessel or vessels to be constructed; or, than one-half the cost of the equipment hereinbefore authorized for a vessel already built: *Provided, however,* If security is furnished in addition to the mortgage on the vessel or vessels, the board may increase the amount loaned, but such additional amount shall not exceed one-half the market value of the additional security furnished, and in no case shall the total loan be for a greater sum than two-thirds of the cost of the vessel or vessels to be constructed; or, than two-thirds of the cost of the equipment, and its installation, for vessels already built.

"(f) The board shall require such security as it shall deem necessary to insure the completion of the construction or equipment of the vessel within a reasonable time and the repayment of the loan with interest; when the vessel is completed the security shall include a preferred mortgage on the vessel, complying with the provisions of section 30 of the Merchant Marine Act, 1920, which mortgage shall contain appropriate covenants and provisions to insure the proper physical maintenance of the vessel, and its protection against liens for taxes, penalties, claims, or liabilities of any kind whatever, which might impair the security for the debt. It shall also contain any other covenants and provisions the board may prescribe, including a provision for the summary maturing of the entire debt, for causes to be enumerated in the mortgage.

"(g) The board shall also require and the security furnished shall provide that the owner of the vessel shall keep the same insured against loss or damage by fire, and against marine risks and disasters, and against any and all other insurable risks the board specifies, with such insurance companies, associations or underwriters, and under such forms of policies, and to such an amount, as the board may prescribe or approve; such insurance shall be made payable to the board and/or to the parties, as interest may appear. The board is authorized to enter into any agreement that it deems wise in respect to the payment and for the guarantee of premiums of insurance."

SEC. 2. That section 12 of the Merchant Marine Act, 1920, be, and the same is hereby, amended by adding at the end thereof a new paragraph to read as follows:

"The term 'reconditioned' as used in this section includes the substitution of the most modern, most efficient, and most economical types of internal-combustion engines as the main propulsive power of vessels. Should the board have any such engines built in the United States and installed, in private shipyards or navy yards of the United States, in one or more merchant vessels owned by the United States, and the cost to the board of such installation exceeds the amount of funds otherwise available to it for that use, the board may transfer to its funds from which expenditures under this section may be paid, from its construction loan fund authorized by section 11 of the Merchant Marine Act, 1920, so much as in its judgment may be necessary to meet obligations under contracts for such installation; and the Treasurer of the United States shall, at the request of the board, make the transfer accordingly: *Provided,* That the total amount here after expended by the board for this purpose shall not in the aggregate exceed $25,000,000. Any such vessel hereafter so equipped by the board under the provisions of this section shall not be sold for a period of five years from the date the installation thereof is completed, unless it is sold for a price not less than the cost of the installation thereof and of any other work of reconditioning done at the same time plus an amount not less than $10 for each deadweight ton of the vessel as computed before such reconditioning thereof is commenced. The date of the completion of such installation and the amount of the dead-weight tonnage of the vessel shall be fixed by the board: *Provided further,* That in fixing the minimum price at which the vessel may thus be sold the board may deduct from the aggregate amount above prescribed 5 per centum thereof per annum from the date of the installation to the date of sale as depreciation; *And provided further,* That no part of such fund shall be expended upon the reconditioning of any vessel unless the board shall have first made a binding contract for a satisfactory sale of such vessel in accordance with the provisions of this Act, or for the charter or lease of such vessels for a period of not less than five years by a capable, solvent operator; or unless the board is prepared and intends to directly put such vessel in operation immediately upon completion. Such vessel, in any of the enumerated instances, shall be documented under the laws of the United States and shall remain documented under such laws for a period of not less than five years from the date of the completion of the installation, and during such period it shall be operated only on voyages which are not exclusively coastwise."

Approved, June 6, 1924.

THE WHITE HOUSE
WASHINGTON

June 6, 1924.

My dear Mr. Palmer:

I have pleasure in sending you herewith the pen used by the President today in signing H. R. 6202, entitled "An Act to amend sections 11 and 12 of the Merchant Marine Act, 1920."

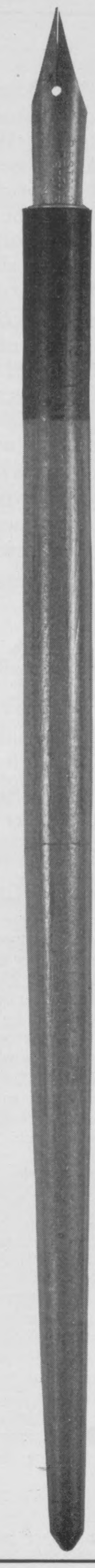
Sincerely yours,

C B Slemp

Secretary to the President.

Mr. Russell Palmer,
Motorship,
27 Pearl Street,
New York, N. Y.

Enclosure.



Placing Our Merchant Marine on a Solid Foundation Will Be Accomplished if Shipowners Take Full Advantage of the Act Signed by This Pen.

The Board's "Ship Sales For Conversion" Contract

While this Verbatim Contract Contains the Terms Under Which Shipping Board Steamers Will be Sold for Conversion, It Is Subject to Minor Modifications.

Foreword

THE Shipping Board has sought to encourage the development of the motorship in the United States, and to this end since 1921 has offered to sell to American companies certain vessels with relatively defective or damaged machinery at prices which amount to practically hull valuations, provided the purchasers will enter into a contract guaranteed by a performance bond, agreeing to accomplish the conversion of the ships to an approved design of Diesel propulsion. The Board has thus far disposed of 13 ships.

As a result of the physical survey of the Board's fleet in 1923 a specific group of about 350 vessels was set aside and given the designation of Class "D" vessels deemed potentially suitable only for conversion to motorships, due to their requiring major alterations and changes in propulsive machinery, the cost of which would not justify such work. The steel cargo-vessels in Class "D" have been assigned basic prices equalling approximately $7.00 per deadweight ton, and the refrigerator and tank steamers in this class have been assigned basic prices of about $15.00 per d.w. ton.

Whilst it is considered that fair progress has been made in this direction from the Shipping Board's sales program, it has been quite apparent that American capital is lacking for the investments required to carry the work forward on the necessary scale. To this end, the Shipping Board supported HR 6202 amending Section 11 and 12 of the Merchant Marine Act, 1920, so that the moneys in the Construction Loan Fund might be used to assist private owners to finance conversions and might also be used by the Shipping Board in conversion for its own account.

It is confidently expected that the sales of vessels on a Diesel conversion basis will be somewhat accelerated by the passage of this Act. It will be observed that the Board is required to charge a minimum of $10.00 per deadweight ton, plus the cost of conversion, for any of its vessels which are converted by the Board and later sold. The same rate per d.w. ton will be charged when the purchaser of tonnage desires to undertake his own conversion, and to obtain a loan from the Board in this connection, as authorized by the Act. To those companies who are prepared to finance their entire undertaking, however, the sale of prices for Class "D" vessels as outlined above, will remain in effect.

The following is a typical form of contract:

THIS AGREEMENT made this day of between the UNITED STATES OF AMERICA, hereinafter called "Seller," represented by the United States Shipping Board acting by and through the United States Shipping Board Emergency Fleet Corporation, a District of Columbia corporation, and the a corporation, with its principal place of business at hereinafter called "Buyer,"

WITNESSETH:

WHEREAS, the Seller has advertised certain vessels for sale, among them the ss. "steamer," hereinafter referred to; and

WHEREAS, the Seller has agreed to sell and the Buyer has agreed to purchase the said ss. "steamer," following said advertisement upon the terms hereinafter set forth; and

WHEREAS, one of the said conditions upon which the Seller has agreed to sell to the Buyer the said ss. "steamer," is in substance that the Buyer shall be required to replace the present propelling machinery installation with Diesel driven propelling plant in accordance with general plans and specifications, which plans and specifications must be approved by the Seller; and

WHEREAS, the parties hereto regard the installation of said Diesel driven propelling plant in said vessel as of great importance in order to determine the value of such plant with respect to the type of vessel to which said belongs; and

WHEREAS, said installation to be made by said Buyer as hereinafter provided, is a substantial part of the consideration of this agreement.

NOW, THEREFORE, the parties hereto agree as follows:

FIRST:—The Seller agrees to sell and the Buyer agrees to purchase the ss. "steamer," Official Number 0000, of an approximate dead weight tonnage ——— "as is, where is" at the time of delivery as hereinafter provided, except submarine signal apparatus, consumable stores and bunker fuel and that part of the present steam machinery or plant that shall not be required in making the modifications, alterations and changes hereinafter provided, without warranty or guaranty of any sort as to capacity, quality, tonnage or condition upon the terms and conditions hereinafter set forth.

SECOND:—It is understood and agreed between the parties hereto that the Seller shall be the sole judge as to whether any part of the steam machinery or plant is not required in making said modifications, alterations and changes. The Buyer agrees, at its own cost and expense, to remove that part of the steam machinery or plant not required in making said modifications, alterations and changes, and either place the same in storage for account of the Seller or load on railroad cars or lighters, at the option of the Seller.

THIRD:—The Buyer agrees that the Seller shall have the right to use and operate said vessel until the vessel completes her present commitment without liability whatsoever in case said vessel is lost.

FOURTH:—The Seller agrees, upon the first arrival of said vessel at a port in the United States after the termination of her present commitment, to place the vessel at said port at the disposal of the Buyer for dry dock inspection, and the Buyer agrees to receive said vessel at such port for such inspection.

FIFTH:—The Seller agrees that the Buyer shall have the right to conduct bottom inspection of said vessel on dry dock, at its risk and expense. The Buyer agrees that if it demands such dry dock bottom inspection of the vessel it will, within five (5) days after notification from the Seller to the Buyer that said vessel is available for dry dock bottom inspection, deposit with the Seller prior to the removal of the vessel for such dry dock bottom inspection, the amount estimated by the Seller to be sufficient to cover the expense to be incurred by it for, and incident to such inspection. The Buyer hereby authorizes and empowers the Seller to pay from such deposit all expenses incurred by the Seller from time of removing said vessel from her location at the time said vessel is placed at the disposal of the Buyer for such examination, to the place designated by the Buyer for dry dock bottom inspection, and in the event this contract is terminated as hereinafter provided, all the expenses incurred by the Seller in removing said vessel from the dry dock to the location at which the vessel was first placed at the disposal of the Buyer for dry dock inspection or to such place as may be mutually agreed upon, including tug hire, wages of crew, victualling, fueling, provisioning, survey fee of representative of Marine Insurance Department of the Seller, and without limitation of the foregoing any and all expenses accruing from the time notification is given the Buyer that said vessel is available for removal to the place designated by the Buyer for dry dock bottom examination up to the time of delivery of the vessel to the Buyer and or in the event of the termination of the agreement as hereinafter provided, up to the time said vessel is removed to the location at which she was first placed at the disposal of the Buyer for dry dock inspection, or to such other place as may be mutually agreed upon. The unexpended balance of said deposit, if any, is to be returned to the Buyer. The amount over and above said deposit expended by the Seller, if any, shall be paid to the Seller by the Buyer immediately upon presentation of invoice showing such expenditure.

SIXTH:—The Buyer further agrees to furnish the Seller evidence, prior to removal of the vessel for dry dock bottom inspection, that said vessel is covered by marine insurance in form approved by the Marine Insurance Department of the Seller, covering risk incident to removal and dry dock examination.

SEVENTH:—The Seller agrees that if bottom damage, recognized by the Seller as being covered under its form of insurance policy, is disclosed upon such dry dock bottom inspection and such damage exceeds $1,000, as determined by the Marine Insurance Department of the Seller, the Seller, at its option, may allow a credit to the Buyer on the purchase price of said vessel equivalent to the amount of insurance damage disclosed in excess of $1,000 as determined by the Marine Insurance Department of the Seller, or the Seller may refuse to allow such credit. In the event the Seller refuses to allow such credit to the Buyer for insurance damage disclosed in excess of $1,000, the Buyer shall have the right to terminate this contract, provided, however, such termination shall be in writing and made within five (5) days after the Seller's refusal, and provided, further, that the Buyer shall not be released from the payment of the expenses incident to the removal of the vessel and to bottom inspection as herein above provided.

EIGHTH:—The Buyer agrees to accept delivery of said vessel "as is, where is" on dry dock immediately upon completion of dry dock bottom inspection as aforesaid, unless this contract is terminated by the Buyer as hereinbefore provided.

NINTH:—The Seller agrees to deliver to the Buyer a bill of sale for said vessel, bargaining and selling all the right, title and interest of the United States of America in and to said vessel with warranty against liens as of the date thereof, simultaneously with the delivery of said vessel to the Buyer.

TENTH:—As part of the consideration for said sale the Buyer agrees to pay to the Seller the sum of $, as follows:

Two and one-half per cent or paid by certified check accompanying the Buyer's bid for said vessel, receipt whereof is hereby acknowledged.

Seven and one-half or $ to be paid in cash, or certified check payable to the order of the United States Shipping Board Emergency Fleet Corporation, within five (5) days after notification to the Buyer that said vessel is available for removal for dry dock bottom inspection but in any event prior to placing said vessel on dry dock for bottom inspection.

The balance $, in cash, or certified check payable to the order of the United States Shipping Board Emergency Fleet Corporation, at the time the said bill of sale for the vessel is delivered to the Buyer.

ELEVENTH:—As the balance of the consideration for said sale the Buyer does hereby covenant and agree with the Seller as follows:

(a) The Buyer will, immediately upon completion of said dry dock bottom inspection, remove the said vessel from the dry dock to the plant or yard of the contractor employed to make the changes, alterations and installations as hereinafter agreed. Said plant or yard shall be situated and the Buyer agrees that such changes, alterations and installations shall be made, within the continental limits of the United States.

(b) The Buyer agrees to make or cause to be made, with reasonable dispatch, such hull modifications to said vessel and such other changes, alterations, etc., as may be necessary to adapt her to the installation of one reversible heavy duty Diesel engine, with cylinders of bore and stroke, scavenged by the method. Said engine shall be SHP at R.P.M.

(c) On completion of said hull modifications and alterations above referred to, the Buyer agrees to install said Diesel engine, together with all auxiliaries and cargo pumps and to do all other work necessary to condition said vessel ready for service as a complete screw motor.

(d) The Buyer agrees that said modifications and alterations and changes shall comply in subsance with the general plans or drawings and specifications therefor, copies of which are attached and marked Exhibits "B" and "C" respectively, with the understanding that the Buyer may make such reasonable modifications thereto as may be necessary properly to complete said hull modifications and alterations and changes and condition said vessel for service as hereinabove set forth.

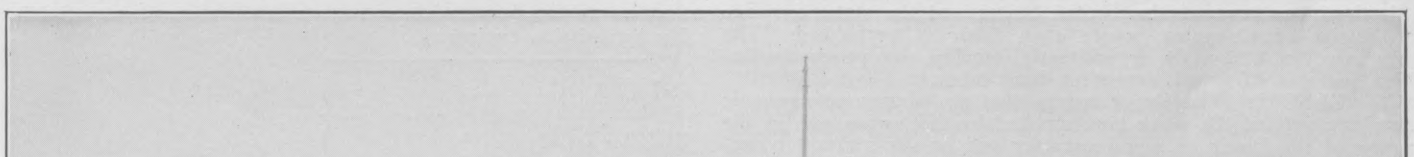
(e) The Buyer agrees thereupon to make such trials reasonably necessary to determine the speed and other results of the work contemplated herein and on demand of the Seller to furnish it with the information and engineering data as to the performance of the machinery and vessel on the trial trip or trips set forth in Exhibit "A" attached hereto and made a part hereof. The Buyer agrees to permit representatives of the Seller to visit and examine the vessel at all reasonable times while the Buyer is making hull modifications and installing said engine and likewise to be present at all formal trials thereof.

(f) The Buyer agrees that it will not operate said vessel, or cause or permit it to be operated, other than as required or permitted by Clause (a) of this TENTH paragraph until after completion of said hull modifications and alterations and the installation of said engine, as herein set forth.

(g) The Buyer further agrees in the event said vessel is lost or destroyed, after delivery to the Buyer, at any time before the installation of the full Diesel driven propelling plant and the auxiliaries thereto and the trial trip has been made, that it will pay promptly, after such destruction or loss, to the Seller, the further sum of

TWELFTH:—The Buyer agrees to complete the hull modifications, alterations and installation of said engine and all other duties referred to herein and to have said vessel ready for service within moths from the date of this contract.

PROVIDED, HOWEVER, that in the event of delay in completing the hull modifications, alterations and installing said engine and all other duties referred to herein the Seller is satisfied that such delay has been caused by weather conditions, act of God, fires, strikes, delay in delivery of material by sub-contractors, or without limiting the foregoing, any other cause beyond the control of the Buyer then the Seller may in writing extend the time for completing the hull modifications, alterations and installations of said engine and all other duties referred to herein for such a period, as in the judgment of the Seller, shall be just, reasonable and proper; but such extension or extensions shall in no manner affect the rights and obligations of the parties under this contract, but the same shall subsist, take effect, and be enforcible precisely as if the new date or dates had been the date originally agreed upon;



The Shipping Board's motorship "William Penn" started as a single-screw steamship but changed to Diesel drive.

the decision of the said Seller as to the existence of the cause or causes of delay in completing the hull modifications and alterations and all other duties referred to herein within the time required by the terms of this contract, and also as to the extension of time which may be allowed is to be final and conclusive upon both parties to this contract; PROVIDED, FURTHER, the Buyer agrees to give the Seller prompt notice by registered mail of the happening of any of the aforementioned events causing delay not later than five (5) days after the beginning thereof, and also to give notice in like manner of the termination of such events not later than five (5) days after such termination; otherwise, no extension of time shall be granted or allowed.

THIRTEENTH:—The Buyer agrees that should it fail to do any of the things in this agreement provided to be done by it the Seller will be greatly damaged and that such damages cannot be ascertained with any degree of definiteness or certainty. In order to protect itself against such indefiniteness and uncertainty of liability the Buyer hereby covenants and agrees:

1. In the event the Buyer shall fail or refuse to have said changes, alterations and installations made at a shipyard or plant situated within the continental United States pursuant to this agreemet, it will pay the Seller as and for liquidated damages, and not a penalty, the sum of ;

2. In the event the Buyer shall fail to have the said vessel completed and ready for service as a screw Diesel driven pursuant to this agreement within said period of months from the date of this contract, or such extended time as it may be entitled to under the provisions of the TWELFTH paragraph hereof, then, in addition to said sum hereinbefore stipulated, the Buyer agrees to pay the Seller as and for liquidated damages, and not a penalty, the further sum of for each and every day the Buyer shall be in default; and

3. In the event the Buyer shall fail or refuse, for any reason other than the loss or destruction of said vessel, to complete the hull modifications, alterations and the installation of said engine and all other duties referred to herein and to have said vessel ready for service within a period of one hundred (100) days after the end of the period of from the date of this contract, or such extension of time as it may be entitled to under the provisions of the ELEVENTH paragraph, hereof, then, in addition to said sums hereinbefore stipulated the Buyer agrees to pay the Seller as and for liquidated damages, and not a penalty, the further sum of .

FOURTEENTH:—The Buyer agrees that all work required in carrying out this contract shall be performed in full compliance with the labor laws of the United States and the state, territory or District of Columbia, where such labor is performed. The Buyer shall not, directly or indirectly, employ any person undergoing sentence of imprisonment at hard labor.

FIFTEENTH:—The Buyer agrees that no laborer or mechanic doing any part of the work contemplated by this agreement, in the employ of the Buyer or any contractor and or sub-contractor contracting for any part of said work contemplated, shall be required or permitted to work more than eight hours in any one calendar day upon such work at the site thereof. For each violation of the requirement of this article a penalty of five dollars ($5.00) shall be imposed upon the Buyer for each laborer or mechanic for each calendar day in which such employee is required or permitted to labor more than eight hours upon said work, and all penalties thus imposed shall be withheld for the use and benefit of the Seller; PROVIDED, That no penalty shall be exacted in case the President, by Executive Order, shall waive the requirements of this article of this agreement, or when violation is due to any extraordinary events or conditions of manufacture, or to any emergency caused by fire, famine, or flood, by danger to life or to property, or by other extraordinary events or conditions on account of which the President shall subsequently declare the violation to have been excusable.

SIXTEENTH:—The Buyer covenants and agrees that no member of or delegate to Congress nor Resident Commissioner is interested in or shall be admitted to any share or part of this contract or to any benefit that may arise therefrom.

SEVENTEENTH:—The Buyer has furnished to the Seller simultaneously with the execution and delivery of this contract, on the part of the Buyer a surety company bond in the sum of conditioned on the full and faithful performance by the Buyer of all of the terms, covenants and conditions to be performed by the Buyer herein.

EIGHTEENTH:—The Buyer covenants and agrees that a waiver by the Seller of a breach of any provision of this agreement shall not be construed as a waiver of any subsequent similar or dissimilar breach on its part.

NINETEENTH:—It is mutually agreed that nothing in this agreement contained shall in any way qualify, limit or affect the unconditional title of the Buyer in and to said vessel.

IN WITNESS WHEREOF, the parties hereto have executed this agreement the day and year first above written.

UNITED STATES OF AMERICA
By
UNITED STATES SHIPPING BOARD
By
UNITED STATES SHIPPING BOARD EMERGENCY FLEET CORPORATION

ATTEST: ____________
Secretary.

ATTEST: ____________
Secretary.

By ____________
President.

By ____________
President.

DISTRICT OF COLUMBIA, } ss.:

I, , a notary Publc in and for the said District of Columbia, hereby certify that and, whose names as President and Secretary, respectively, of the United States Shipping Board Emergency Fleet Corporation, a corporation, are signed to the foregoing instrument and who are known to me, acknowledged before me, on this day, that, being informed of the contents of the said instrument, they, as such officers and with full authority, executed the same voluntarily for and as the act of said corporation and for and as the act of the United States Shipping Board.

IN WITNESS WHEREOF, I have hereunto affixed by hand and official seal this day of

____
Notary Public.

My commission expires
____

STATE OF
} ss.:
COUNTY OF

In this day of , in the year , before me , a Notary Public, personally appeared , known to me to be the President of the , the corporation that executed the attached instrument and acknowledged to me that such corporation acknowledged the same.

____
Notary Public.

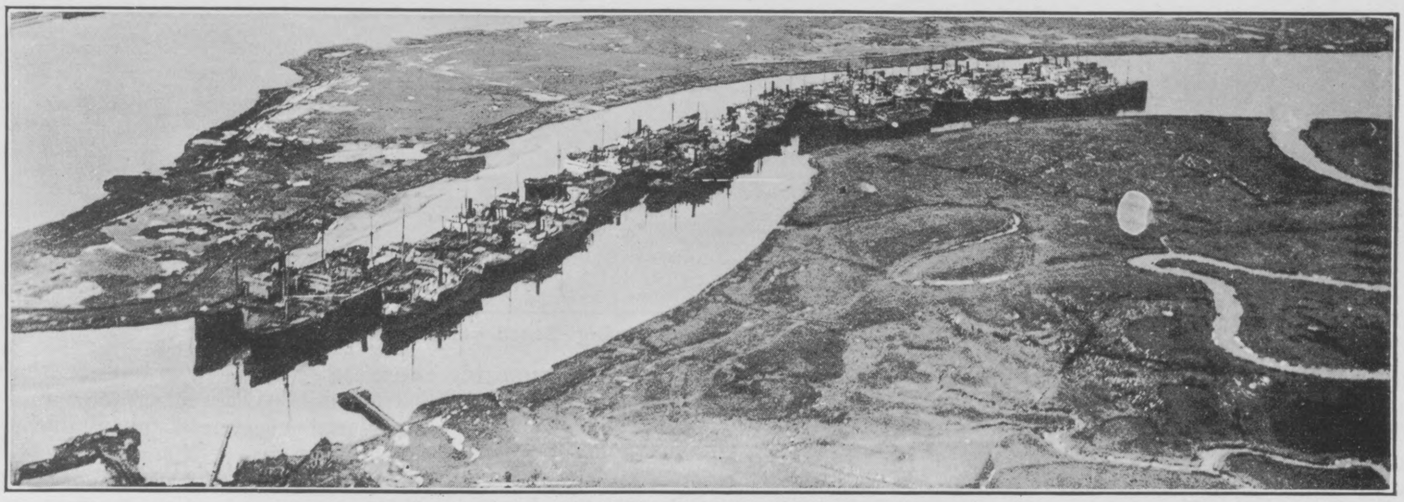
APPROVED AS TO FORM:

____________,
Assistant Counsel.

____________,
General Counsel.

APPROVED AS TO SUBSTANCE:

____________,
Manager, Ship Sales Department.



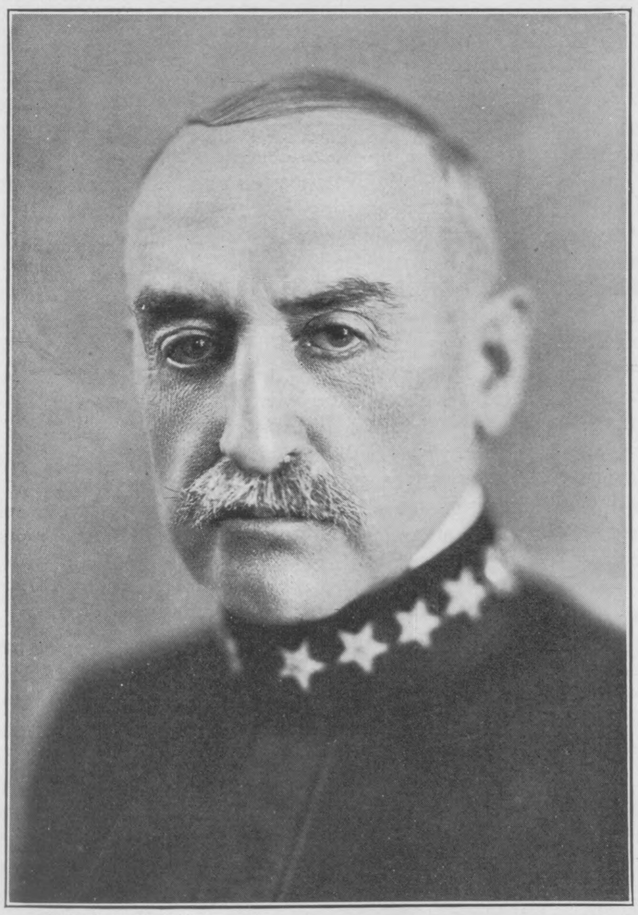
Staten Island fleet No. 4 of Shipping Board vessels

Some Operative and Engineering Aspects of Diesel Conversion.

By ANGELO CONTI

An Intensive Development of Our Diesel Engine Industry Should Permit the Economical Conversion of Obsolescent Steam Tonnage into Competitive Units and Materially Reduce Operating Expenses. Various Aspects of the Past and Present Situation Concerning the Government's Merchant Fleet are Reviewed on the Several Following Pages in a Comprehensive Manner by the Consulting Engineer to the Shipping Board and Formerly Manager of the Technical Department of the Emergency Fleet Corporation.—Editor.

THE recently enacted legislation permitting the use of the Construction Loan Fund for converting to Diesel propulsion private and Government-owned steam tonnage is the first silver lining on the many dark clouds which have been constantly gathering over the future of our merchant marine.



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Admiral Wm. S. Benson, Commissioner of the U. S. Shipping Board, who has fought so hard for the adoption of Diesel engines for Government ships.

The legislation in question was introduced by the late Representative William S. Green, Chairman of the House Committee on Merchant Marine and Fisheries, amending sections 11 and 12 of the Merchant Marine Act of 1920, and fostered by Representative Geo. W. Edmonds.

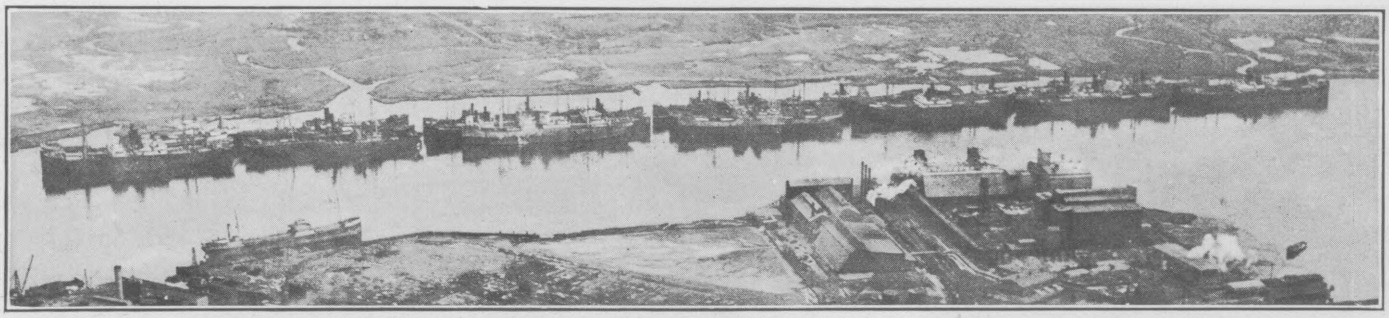
Section 11 originally provided a Construction Loan Fund derived from the proceeds of sale and liquidation of Shipping Board plants, vessels, and surplus materials, at the rate of $25,000,000 per year (up to a maximum of $125,000,000) to be loaned at a nominal rate of interest to American citizens for the construction in domestic shipyards of vessels equipped with the most modern and economical machinery and appliances. Under this Section approximately $67,000,000 is at present available and Section 12 as now amended allots $25,000,000 of this fund to the Shipping Board for the conversion of its own vessels. The remaining fund, amounting to about $42,000,000, is available for a similar rehabilitation of either privately-owned steamers or of Government-owned tonnage which private interests may wish to purchase for this purpose, as well as for new motorship construction.

During the four-year period between 1917 and 1921, there were built under Government supervision approximately 1,700 steel vessels, aggregating about 11,600,000 d.w.t., of which number at the signing of the Armistice on November 11, 1918, 400 ships of about 2,500,000 d.w.t. had been completed and 515 hulls of 3,275,000 d.w.t. had been launched.

During the emergency period many factors were naturally subordinated to the expediency of rapid mass production, but shortly after the cessation of hostilities the construction program was greatly curtailed, and, wherever possible, improved.

The propelling and auxiliary machinery, however, had reached such an advanced stage of production that, excepting a few cases, only minor improvements were possible with the result that quite a number of Shipping Board vessels were equipped with deficient propelling plants in varying degrees according to the combination of machinery used. These shortcomings were mainly confined to geared turbines and water tube boilers, and the vessels so affected were gradually retired from operation.

Faced with the alternative of disposing of these deficient



Staten Island fleet No. 2 of Shipping Board vessels.

steamers in a constructive manner or of relegating them to the scrap heap, some three years ago the Shipping Board adopted the policy of selling these vessels at a nominal value providing they were converted to motorships in an acceptable manner, and 14 vessels have already been so treated.

Preliminary to the adoption of a constructive policy towards the disposal of the Government fleets, in the summer of 1923 the Shipping Board ordered a comprehensive survey of its idle fleets. As a result of this survey all vessels were eventually classified according to type and fitness of service and were also assigned individual values, taking into account the depreciated state of the ship market. Accordingly, the vessels were classified under the following headings:

Class A—Steel vessels of good design, well built, equipped with reliable machinery and deck auxiliaries, and capable of continuous operation with normal upkeep. The estimated cost of repairs varies from a maximum of $15,000 for "lakers" to a maximum of $35,000 for all other types.

Class B—Of the same type as Class A, but requiring repairs and overhauling in excess of $35,000.

Class C—Well built steel hulls of good type and in a fair state of preservation, but less desirable than A and B by reason of deficient machinery, which could be replaced at varying costs up to a maximum of $100,000 per ship. Vessels of this class are all fitted with Scotch boilers and geared turbines.

Class D—Includes vessels of good design and competitive type, but generally fitted with a combination of geared turbines, water-tube boilers and deficient deck and engine-room auxiliaries requiring extensive replacements, and are, therefore, desirable hulls for conversion to Diesel propulsion.

Class E—Vessels considered in general unsuitable for American flag operation.

Class F—Vessels of obsolete types, too old or badly damaged to be serviceable.

In addition to the above, all other vessels of special type were separately classed as follows:

Passenger vessels—29 including 3 laid up ex-German vessels.

Tugs—35 Wood and steel.

Vessels Available for Diesel Conversion

The vessels which, in view of the legislation previously referred to, are of particular interest in this article, are those included in Class D. Comprising well built hulls of competitive types, obtainable at nominal price, this class represents the largest portion of the world's tonnage most ideally suitable for conversion purposes.

It is well to note that these vessels are from 4 to 5 years old as an average and fairly well preserved; once they are thoroughly overhauled, they might be considered as good as new. The replacement of their deficient propelling plants with improved steam machinery would undoubtedly enhance reliability and also economy to a lesser extent, but the resultant benefits would be quite incommensurate to the cost involved.

Further, in view of the ever increasing number of new and converted motorships, even with the unavoidable improvements in the Diesel art, at the end of 6 or 7 years a steam plant would suffer greater obsolescence, whereas a converted vessel would be more desirable and possess a market value proportionately much greater than as a steamer. On the other hand, if nothing is done with these vessels, as they are not marketable in their present condition they would be doomed to ultimate decay.

Therefore, all considerations logically point to the desirability of quickly converting these vessels, taking full advantage of the financial help afforded by the Board, and in order to assist prospective purchasers we have endeavored to describe and illustrate the various types available by means of especially compiled tabulated data.

In the machinery particulars we have included such information as: length of engine and boiler rooms, size and length of shafting, and maximum diameter of propeller permitted by the stern frame, as these factors affect the selection of the power plant.

Under the hull data will be found detailed information on cubic capacities including the amidship tween-decks above engine and boiler rooms where such space can be reclaimed for cargo, as is usually the case in a converted vessel with tween decks. We have also included a statement of tank capacities, those arranged for fuel having been expressed in terms of 28 Beaumé oil at 40 cu. ft. to the ton, so they can easily be converted to oils of different gravity if so desired. The information has been generally presented in a uniform manner, and while no efforts were spared to insure its being correct, we cannot vouch for the accuracy of the drawings from which such information was obtained.

It should be noted that the vessels of designs 1,135 and 1,032 are not presently included under Class D, and are being considered for conversion by the Shipping Board when engines of suitable power can be eventually secured at a reason-

Angelo Conti, consulting engineer to the special advisory committee appointed by the Shipping Board to recommend types of Diesel engines for conversion of the ships under the Board's program, who has prepared the ship data on pages 15 to 45 inclusive, especially for Motorship.

able cost. Likewise the vessels of design 1,027 will, most likely, be included in the Board's initial conversion program and may not be available for sale. Information on these three designs, however, has been given as a matter of general interest.

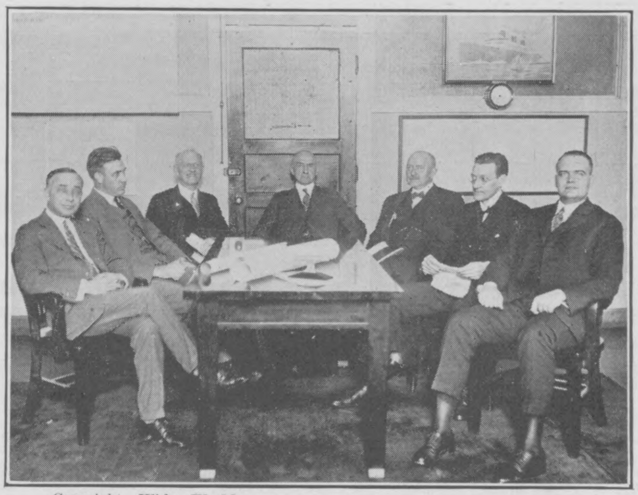
To facilitate an analytical comparison of available vessels they have been grouped according to type, and their principal characteristics summarized in tables 1, 2 and 3. For general guidance we have also added the approximate maximum power, revolutions and speed permissible with the existing line of shafting according to the present rules of the American Bureau of Shipping.

The range of economical speed can be gauged by the effective horsepower given in these tables. In certain cases where no model tank experiments are available an estimate of effective horsepower has been given. For design 1,027 the E.H.P. for model 1,037 may be used. Likewise, the E.H.P. of model 1,025 will obtain for the *Auburn*.

As regards the remaining vessels of the 8,800 D.W.T. class, represented by designs 1,016, 1,019 and 1,013, it has been found that the E.H.P. of model 1,016 appears to be the most consistent with the results from actual operation, and, in our opinion, it should be used in preference to the other two models.

In order to provide for the increased resistance due to the progressive fouling of the ships' bottoms between dry-docking, the experimental E.H.P. should be increased by at least 15 per cent., otherwise the desired sustained sea speed may not be realized. And as in the case of slow-speed vessels of rather full lines the frictional resistance amounts to approximately 60 per cent. of the total, this 15 per cent. allowance actually represents an increase of 25 per cent. in frictional resistance.

It should be noted that with Diesel machinery the elements affecting economy of operation are entirely automatic and largely independent of the engineer's operating skill. The admission of fuel is under governor control so that in bad weather dangerous racing is considerably reduced. Further, with Diesel engines of conservative design the rated power is ever readily available and moderate overloads can be maintained for reasonable periods. These factors, as contrasted to the fluctuations of operating conditions obtaining with a steam plant, actually mean that a motorship usually maintains a slightly greater speed than a sister steamship of equal power. If the higher cost of Diesel propelling machinery is also taken into account it then appears unnecessary to provide a margin of power for bad weather, over and above the 15 per cent. allowance to care for the unavoidable increase in frictional resistance.



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Special Advisory Committee appointed by the Shipping Board to recommend types of Diesel engines for conversion of ships under the Board's program. Left to right: Angelo Conti, Consulting Engineer; J. F. Nichols, Chief Engineer, Newport News Shipbuilding & Dry Dock Co.; Admiral H. I. Cone, Chairman of the Committee and Assistant-President of the Emergency Fleet Corp.; Admiral Wm. S. Benson, Commissioner United States Shipping Board; Capt. Chas. A. McAllister, Vice-President American Bureau of Shipping; Wm. F. Gibbs, Consulting Naval Architect to the Board; Major W. Styer, Engineer Corps. U. S. War Dept.

TABLE I—CLASS D—FREIGHTERS: 342 VESSELS—2.543.500 D. W. T.

Design No.	No. of ships	Average D.W.T.	Type of Constr.	No. of complete decks	Principal dimensions: Length B. P.	Beam moulded	Depth moulded	Summer draft	Block Coeff.	Load Displ. tons	Max. bale capacity	Ratio of cubic to D. W. T.	Engine room, length	Approx. Cond. to suit shafting: Line shaft diam.	R.P.M.	S.H.P.	Knots	Effective horse power: 9 knots	10 knots	11 knots	12 knots
1,135	8	12,900	Longit..	2	439′ 6″	60′ 0″	36′ 8″	28′ 4¾″	.806	17,000	631,300	49.0	48′ 0″	13½″	90	3,200	10.85	840	1,160	1,570	2,090
1,032	3	11,800	Longit.	2	440′ 1½″	56′ 0″	38′ 0″	28′ 7½″	.808	15,946	585,600	49.6	55′ 0″	14″	90	3,200	10.75	880	1,240	1,690	2,110
1,037	16	9,725	Longit.	2	395′ 6″	55′ 0″	34′ 11″	27′ 0″	.795	13,140	452,750	46.6	52′ 6″	13¼″ 13″	39 37	2,500 2,250	10.7 10.3	780	1,040	1,370	1,780
1,027	9	9,525	Longit.	2	402′ 0″	54′ 0″	33′ 9″	26′ 10¾″	.801	12,910	486,700	51.0	52′ 0″	13″	89	2,300	10.3	.....	.....	.....	.....
1,015	38	9,433	Longit.	2	402′ 6″	53′ 0″	34′ 6″	26′ 4¾″	.801	12,625	456,680	48.4	50′ 0″	13″ 13⅜″	95 96	2,500 2,700	10.6 11.1	710	985	1,330	1,860
Auburn	1	8,868	Tvansv.	2	401′ 0″	54′ 0″	32′ 9″	25′ 7″	.798	12,225	424,960	48.0	51′ 9″	14″	20	3,200	11.0	.....	.....	.....	.....
1,025	75	8,735	Tvansv.	2	401′ 0″	54′ 0″	32′ 10″	25′ 2″	.804	12,225	441,780	50.6	51′ 9″	13¼″	85	2,500	10.25	750	1,065	1,480	2,000
1,016	14	8,729	Longit.	2	410′ 5½″	54′ 0″	30′ 0″	24′ 1″	.82	12,260	417,780	47.8	49′ 6″	12½″	92	2,100	10.25	735	1,000	1,340	1,820
1,019	17	8,366	Trans..	2	410′ 5½″	54′ 0″	29′ 9″	24′ 2″	.817	12,220	426,220	51.0	49′ 6″	12½″ 13⅜″	92 92	2,100 2,600	10.2 11.0	660	900	1,210	1,620
1,013	8	8,430	Trans..	2	410′ 5½″	54′ 0″	29′ 9″	23′ 11¼″	.806	12,086	410,000	48.6	49′ 6″	13¼″	90	2,600	11.2	640	880	1,210	1,640
1,014	7	7,651	Longit.	2	380′ 6″	53′ 0″	29′ 3″	23′ 8″	.796	10,732	371,640	48.6	50′ 0″	12 11/16″	92	2,200	10.6	650	890	1,200	1,600
Mt. Shasta	1	7,242	Transv.	2	376′ 0″	52′ 3″	28′ 0″	22′ 11″	.791	10,170	333,200	46.0	48′ 9″	13″	.....	.....	.....	.....	.....	.....	.....
1,152	5	6,306	Longit.	2	340′ 0″	49′ 0″	28′ 7¾″	23′ 1½″	.821	8,830	308,450	49.0	44′ 0″	11⅛″	.....	.....	.....	550	780	1,120	1,640
1,021	2	5,940	Transv.	2	341′ 0″	48′ 0″	27′ 3″	22′ 4″	.812	8,475	262,640	44.0	45′ 10″	12½″	.....	.....	.....	540*	770*	1,100*	1,600*
1,023	112	5,300	Transv.	1	324′ 0″	46′ 0″	28′ 6″	22′ 11″	.789	7,535	226,150	42.7	47′ 3″	10 9/16″	.....	.....	.....	470	660	910	1,280
1,038	8	5,273	Transv.	1	324′ 0″	46′ 0″	27′ 8″	23′ 0 13/16″	.789	7,560	232,260	44.1	47′ 3″	11½″	.....	.....	.....	.....	.....	.....	.....
1,043	4	5,128	Transv.	2	320′ 9″	46′ 0″	26′ 9″	22′ 1 9/16″	.802	7,489	212,070	41.4	49′ 6″	12½″	.....	.....	.....	520	715	1,005	1,410
1,149	2	3,909	Transv.	1	300′ 0″	44′ 0″	22′ 3″	19′ 0″	.791	5,665	168,120	43.0	42′ 0″	10½″	.....	.....	.....	420*	560*	830*	.....
1,020	12	3,545	Transv.	1	251′ 0″	43′ 6″	24′ 2½″	21′ 3″	.805	5,280	161,410	45.5	44′ 0″	10″ 11⅛″	.....	.....	.....	420*	585*	830*	.....

Staten Island fleet No. 1 of Shipping Board vessels.

TABLE II — CLASS D — TANKERS: 8 VESSELS — 65,869 D. W. T.

Design No.	No. of ships	Average D.W.T.	Type of Constr.	No. of complete decks	Principal dimensions				Block Coeff.	Load Displ. tons	Dry cargo, bales	Oil cargo, bbls.	Engine room, length	Approx. Cond. to suit shafting				Effective horse power			
					Length B. P.	Beam moulded	Depth moulded	Summer draft						Line shaft diam.	R.P.M.	S. H. P.	Knots	9 knots	10 knots	11 knots	12 knots
Requis.	5	7,030	Longit.	1	365′ 0″	50′ 9″	31′ 3″	24′ 5″	.794	10,225	48,170	57,438	66′ 0″	None.	.....	.....	....	.....	.....	.....	.....
1,059	3	10,250	Longit.	1	430′ 0″	59′ 0″	33′ 3″	25′ 4½″	.802	14,760	35,883	83,146	54′ 0″	12½″	.....	.....	....	790	1,095	1,500	1,940

TABLE III — CLASS D — REFRIGERATORS: 6 VESSELS — 38,974 D. W. P.

Design No.	No. of ships	Average D.W.T.	Type of Constr.	No. of complete decks	Principal dimensions				Block Coeff.	Load Displ. tons	Bales cubic	Refrig. capacity cu. ft.	Engine room, length	Approx. Cond. to suit shafting				Effective horse power			
					Length B. P.	Beam moulded	Depth moulded	Summer draft						Line shaft diam.	R.P.M.	S. H. P.	Knots	9 knots	10 knots	11 knots	12 knots
Requis.	4	5,590	Longit.	2	340′ 0″	49′ 0″	28′ 7¾″	23′ 1½″	.821	8,830	.....	181,765	44′ 0″	11⅛″	.....	.....	....	550	780	1,120	1,640
1,015	2	8,370	Longit.	2	402′ 6″	53′ 0″	34′ 6″	26′ 4¾″	.801	12,625	346,020	307,870	50′ 0″	13⅜″	96	2,700	11.1	710	985	1,360	1,860

Block coefficients figured on length from forward perpendicular to after side of propeller post.
* Estimated.

TABLE IV.— ENGINE DEPARTMENT PAYROLL

Rank	Monthly Wages	Coal Burning Steamer		Oil Burning Steamer		Motorship	
		No.	Wages	No.	Wages	No.	Wages
Chief engineer	$260.00	1	260.00	1	$260.00	1	$260.00
First engineer	185.00	1	185.00	1	185.00	1	185.00
Second engineer	165.00	1	165.00	1	165.00	1	165.00
Third engineer	150.00	1	150.00	1	150.00	1	150.00
Electrician	150.00	..	....	..	....	1	150.00
Oilers	72.50	3	217.50	3	217.50	3	217.50
Firemen, coal	67.50	9	607.50	..	....	..	....
Firemen, oil	65.00	..	....	3	195.00	..	....
Coal passers	60.00	3	180.00	..	....	..	....
Wipers	57.50	..	....	3	172.50	..	....
Monthly total	......	19	$1,765.00	13	$1,345.00	8	$1,127.50
Total wages per annum			21,180.00		16,140.00		13,530.00
Subsistence @ 65c per day			4,507.75		3,084.25		2,198.00
Total wages and subsistence			25,687.75		19,224.25		15,728.00
Excess over motorship			9,959.75		3,496.25		....

Selection of the Most Suitable Type

From the preceding tables it will be noted that while the vessels available for conversion cover a fairly wide range of sizes, their economical speed range is somewhat limited.

As regards type all vessels of approximately 6,000 D. W.T. and over have two decks with a long bridge, poop and forecastle, excepting designs 1,032 and 1,015 which may be considered of the two-deck closed shelter deck type.

Consideration of draft, deadweight and cubic capacity, as well as the depth of holds and the nature of the prevailing cargo, will guide a preliminary selection of the type most suitable for a certain trade, also whether or not deep tanks are needed for ballast or liquid cargo. The size and number of hatches, type and arrangement of cargo-handling gear, as well as the fuel oil capacity of the tanks are other factors that need be considered.

By reason of the greatly decreased fuel consumption, however, it will be generally found that a converted vessel can bunker sufficient fuel-oil for the round trip on the capacity of her inner bottoms alone, thus leaving the deep tanks uncontaminated and always available for cargo.

In general the weight of a Diesel propelling-plant and attendant auxiliaries will not materially exceed the original steam installation, except the combination of geared turbines and water-tube boilers or cases where higher speeds are desired, with consequent heavier engines of greater power.

TABLE V — FUEL CONSUMPTION — OIL BURNING STEAMER AND MOTORSHIP — 8,560 D.W.T.

Range	North Atlantic — United Kingdom		North Atlantic — River Plate	
Round voyage, nautical miles	6,700		12,000	
Average speed, knots per hour	10		10	
Days at sea, round voyage	28		50	
Days in port, round voyage	22		30	
Turnaround	50		80	
Type of vessel	Steamer	Motorship	Steamer	Motorship
Days at sea, per annum	187	198	208	221
Days in port, loading and unloading, per annum	143	152	122	129
Drydocking and overhauling, per annum	35	15	35	15
Round voyages, allowing five days for bad weather, per annum	6.5	6.9	4.06	4.31
Daily fuel at sea, tons	32	10	32	10
Daily fuel in port, loading and unloading, tons	8	0.6	8	0.6
Daily fuel in port, drydocking and overhauling, tons	3	0.25	3	0.25
Total fuel at sea, tons per annum	5,984	1,980	6,656	2,210
Total fuel in port, loading and unloading, tons per annum	1,144	91	976	77
Total fuel in port, drydocking and overhauling, tons per annum	105	4	105	4
Total fuel, all purposes, tons per annum	7,233	2,075	7,737	2,291
Fuel bunkered at home ports, per annum	7,233 @ $11	2,075@$14	6,842 @ $11	2,291@$14
Fuel bunkered abroad, per annum	....	....	895 @ $14	....
Cost of fuel bunkered at home ports, per annum	$79,563.00	$29,050.00	$75,262.00	$32,074.00
Cost of fuel bunkered abroad, per annum	....	....	13,620.00	....
Total cost of fuel, per annum	79,563.00	29,050.00	88,882.00	32,074.00
Difference in favor of Motorship	....	50,513.00	....	56,008.00
Lubricating oil at sea, $ per day	4.00	5.70	4.00	5.70
Lubricating oil in port, $ per day	1.00	1.50	1.00	1.50

TABLE VI — FUEL CONSUMPTION — COAL-BURNING STEAMER AND MOTORSHIP — 8,560 D.W.T.

Range	North Atlantic — Australia		North Atlantic — S. E. Africa	
Type of vessel	Steamer	Motorship	Steamer	Motorship
Round voyage, nautical miles	22,000	22,000	16,760	16,760
Average speed, knots per hour	9	10	9	10
Days at sea, round voyage	102	91.7	77.5	70
Days in port, round voyage	*82	78	59	56
Turnaround	184	169.7	136.5	126
Days at sea, per annum	186	192	190	197
Days in port, per annum	144	158	140	153
Drydocking and overhauling, per annum	35	15	35	15
Round voyages, allowing five days for bad weather	1.77	2.03	2.38	2.74
Daily fuel at sea, tons	45	10	45	10
Daily fuel in port, loading and unloading, tons	11	0.6	11	0.6
Daily fuel in port, drydocking, etc., tons	5	0.25	5	0.25
Total fuel at sea, tons per annum	8,370	1,920	8,550	1,970
Total fuel in port, loading and unloading, tons per annum	1,585	95	1,540	92
Total fuel in port, drydocking, etc., tons per annum	175	4	175	4
Total fuel, for all purposes	10,130	2,019	10,265	2,066
Fuel bunkered in home ports, per annum	4,475 @ $8.55	2,019@$14	6,000 @ $8.55	2,066@$14
Fuel bunkered abroad, per annum	5,655 @ $7.37	....	4,265 @ $7.40	....
Cost of fuel bunkered at home ports, per annum	$38,260.00	$28,265.00	$51,300.00	$28,925.00
Cost of fuel bunkered abroad, per annum	41,690.00	....	31,560.00	....
Total cost of fuel	79,950.00	28,265.00	82,860.00	28,925.00
Difference in favor of Motorship	....	51,685.00	....	53,935.00
Lubricating oil at sea, $ per day	4.00	5.70	4.00	5.70
Lubricating oil in port, $ per day	1.00	1.50	1.00	1.50

* Extra time of steamer in port due to bunkering coal in foreign ports.

TABLE VII — CARGO-CARRYING CAPACITIES — OIL-BURNING STEAMER AND MOTORSHIP — 8,560 D.W.T.

Range	North Atlantic — United Kingdom		North Atlantic— River Plate	
Type of vessel	Steamer	Motorship	Steamer	Motorship
Fuel carried, outbound, tons	1,200	336	1,770	600
Fresh water carried, outbound, tons	214	54	214	54
Crew and stores carried, outbound tons	40	40	40	40
Light displacement, empty vessel, tons	3,645	3,645	3,645	3,645
Displacement with fuel, water and stores, tons	5,099	4,075	5,669	4,339
Deadweight cargo capacity, outbound, fully laden, tons	7,111	8,135	6,541	7,871
Ratio of cargo capacity to deadweight	83%	95%	76.5%	92%
Fuel consumed, outbound, tons	536	147	1,000	260
Fuel bunkered abroad, tons	....	....	220	....
Fuel carried at time of sailing, homebound, tons	664	187	990	340
Fresh water at time of sailing, homebound, tons	214	54	214	54
Crew and stores at time of sailing, homebound, tons	30	30	30	30
Light displacement, empty vessel, tons	3,645	3,645	3,645	3,645
Displacement with fuel, water and stores, tons	4,553	3,916	4,879	4,069
Deadweight cargo capacity, homebound, fully laden, tons	7,657	8,294	7,331	8,141
Ratio of cargo capacity to deadweight	90.7%	97%	85.7%	95.6%
Deadweight cargo, outbound, long tons	7,111	8,135	6,541	7,871
Deadweight cargo, homebound, long tons	7,657	8,294	7,33 1	8,141
Total, both ways, long tons	14,768	16,429	13,872	16,012
Total D.W. cargo per annum, long tons	95,990	113,360	56,320	69,000
Difference in favor of Motorship	....	18.1%	....	22.5%
Total bale capacity, outbound, cu. ft.	437,300	447,300	*415,300	447,300
Total bale capacity, homebound, cu. ft.	437,300	447,300	415,300	447,300
Total bale capacity, both ways, cu. ft.	874,600	894,600	830,600	894,600
Measurement tons @ 40 cu. ft. per ton	21,865	22,365	20,765	22,365
Total measurement tons per annum	142,120	154,320	90,800	96,390
Difference in favor of Motorship	....	8.6%	....	6.1%
Mean of D.W. and measurement cargoes per annum	119,055	133,840	73,560	82,695
Total difference in favor of Motorship	....	12.4%	....	12.4%

*Steamer's deep tanks used for fuel outbound and unserviceable for cargo homebound

TABLE VIII — CARGO-CARRYING CAPACITIES — COAL-BURNING STEAMER AND MOTORSHIP — 8,560 D.W.T.

Range	North Atlantic — Australia		North Atlantic — South Africa	
Type of vessel	Steamer	Motorship	Steamer	Motorship
Fuel carried, outbound, tons	2,340	1,007	2,348	781
Fresh water carried, outbound, tons	194	100	194	100
Crew and stores, outbound, tons	60	60	60	60
Light displacement, empty vessel, tons	3,627	3,627	3,627	3,627
Displacement with fuel, water and stores, tons	6,221	4,794	6,229	4,568
Deadweight cargo capacity outbound, fully laden, tons	5,989	7,416	5,981	7,642
Ratio of cargo capacity to deadweight	70.0%	86.6%	69.9%	89.3%
Fuel consumed, outbound, tons	2,870	550	2,155	401
Fuel bunkered abroad, tons	3,205	....	1,800	....
Fuel carried at time of sailing, homebound, tons	2,675	457	1,993	380
Fresh water carried at time of sailing, homebound, tons	194	100	194	100
Crew and stores, homebound, tons	60	60	60	60
Light displacement, empty vessel, tons	3,627	3,627	3,627	3,627
Displacement with fuel, water and stores, tons	6,556	4,244	5,874	4,167
Deadweight cargo capacity, homebound, fully laden, tons	5,654	7,966	6,336	8,043
Ratio of cargo capacity to deadweight	66.1%	93.0%	74.0%	93.9%
Deadweight cargo, outbound, long tons	5,989	7,416	5,981	7,642
Deadweight cargo, homebound, long tons	5,654	7,966	6,336	8,043
Total, both ways	11,643	15,382	12,317	15,685
Total D.W. cargo, per annum	20,610	31,225	29,315	42,975
Difference in favor of Motorship	....	51.5%	....	46.6%
Total bale capacity, outbound, cu. ft.	358,790	447,300	358,450	447,200
Total bale capacity, homebound, cu. ft.	344,390	447,300	373,710	447,300
Total bale capacity, both ways, cu. ft.	703,180	894,600	732,160	894,600
Measurement tons @ 40 cu. ft. per ton	17,580	22,365	18,304	22,365
Total measurement tons per annum	31,120	45,400	43,560	61,280
Difference in favor of Motorship	....	45.9%	....	40.7%
Mean of D.W. and measurement cargoes, per annum	25,865	38,310	36,440	52,150
Difference in favor of Motorship	....	48.1%	....	42.9%

The combined effect of decreased fuel consumption and the absence of reserve feed-water will materially increase the net-cargo deadweight capacity, the extent depending on the length of the voyage. Similarly the cubic capacity will be somewhat increased by the addition of spaces previously devoted to coal bunkers, stores or boiler-room casings.

In order to assist prospective purchasers in their selection of a suitable type, the following operating analysis for a vessel of the Robert Dollar type, which may be considered representative of the 8,800 d. w. c., may be found useful. This analysis has been made for two typical oil-burning routes and two typical coal-burning routes of varying distance:

The basic data was obtained from the performance of a number of similar vessels plying the routes under consideration, but the consumption of fuel, feed-water, lubricating-oil, stores and maintenance costs of propelling and deck machinery were somewhat reduced, so as to make the comparison more favorable to the steamer.

The data used for fuel, lubricating-oil and maintenance ot the motorships were based on the performance of the Diesel-driven freighter *William Penn.* The converted vessel was credited with an additional 10,000 cubic feet of cargo space due to the elimination of boiler casing, saddleback, etc., and her annual overhauling period was assumed to be approximately one-half the steamer's; as no time would be consumed in lengthy boiler repairs. The same time in port for loading and discharging cargo and an annual allowance of five days for bad weather was used in all cases. The machinery maintenance charges are naturally considerably lower for the motorship, as the extra repairs to boilers, deck machinery, heating coils and steaming out of fuel tanks need not be considered.

Table IV compares the engine department payrolls for the different types of machinery, based on the present Shipping Board schedule:

SUMMARY OF ANNUAL OPERATING EXPENSES DUE SOLELY TO DIFFERENCE IN THE TYPE OF MACHINERY.

TABLE IX — OIL-BURNING STEAMER AND MOTORSHIP — 8,560 D. W. T.

Range	North Atlantic Ports. United Kingdom		North Atlantic Ports. River Plate	
Round voyage, nautical miles	6,700		12,000	
Type of vessel	Steamer	Motorship	Steamer	Motorship
Wages	$16,380	$13,530	$16,380	$13,530
Subsistence	3,084	2,198	3,084	2,198
Fresh water	2,070	402	2,156	412
Lubricating oils and stores	4,326	3,178	4,395	3,176
Fuel	79,563	29,050	88,882	32,074
Maintenance, repairs and overhauling	8,000	2,000	8,000	2,000
Total expenses for engineering department	$113,423	$50,358	$122,917	$53,390
Difference in favor of Motorship	....	63,065	....	69,527

TABLE X — COAL BURNING STEAMER AND MOTORSHIP — 8,560 D.W. T

Range	North Atlantic Ports. S. E. Africa		North Atlantic Ports. Australia	
Round voyage, nautical miles	16,760		22,000	
Type of vessel	Steamer	Motorship	Steamer	Motorship
Wages	$21,180	$13,530	$21,180	$13,530
Subsistence	4,508	2,198	4,508	2,198
Fresh water	1,950	525	1,935	525
Lubricating oils and stores	4,300	3,052	4,288	3,015
Fuel	82,860	28,925	79,950	28,265
Maintenance, repairs and overhauling	8,000	2,000	8,000	2,000
Total expenses for engine department	$122,798	$50,230	$119,851	$49,533
Difference in favor of Motorship	....	72,568	....	70,318

The fuel consumptions for the various types of vessels on the different routes may be worked out as per Tables V and VI, and the results suitably modified according to the length of voyage and the cost of fuel prevailing at the ports under consideration.

The comparative cargo-carrying capacities for each route can be investigated as per Tables VII and VIII, and the operating expenses affected by the type of machinery as per Tables IX and X, all other expenditures having been omitted as they are substantially the same for both types of vessels. This assumption obtains only when equal amounts of cargo are carried; if the net additional earnings of the motorship need be computed all expenses incidental to handling the extra cargo, such as stevedoring, brokerage, etc., should be deducted from the additional freight revenues.

These comparative performances have been summarized in the following table:

TABLE XI.—SUMMARY OF COMPARATIVE PERFORMANCE—STEAMER AND MOTORSHIP

Route	United Kingdom		River Plate		S. E. Africa		Australia	
Kind of fuel	Oil	Oil	Oil	Oil	Coal	Oil	Coal	Oil
Type of vessel	Steamer	Diesel	Steamer	Diesel	Steamer	Diesel	Steamer	Diesel
Round voyages	6.5	6.9	4.06	4.31	2.38	2.74	1.77	2.03
Extra dw. cargo	......	18.1%	......	22.5%	......	46.6%	......	51.5%
Extra meas. cargo	......	8.6%	......	6.1%	......	40.7%	......	45.9%
Mean of dw. and meas	......	12.4%	......	12.4%	......	43.0%	......	48.1%
Extra cost of operation	$62,825	......	$69,267	......	$72,568	......	$70,328	......

By following a similar procedure the increased cargo capacity and decreased operating expenses can be easily determined for vessels of other types or for different routes.

Engineering Features Affecting Conversion

Once the type most suitable for a certain trade has been selected from the vessels available, the question arises as to how best effect its conversion, and in order that a reliable installation may be obtained at a reasonable cost the many factors involved will need to be carefully analyzed.

Selection of the Main Engine

From the attached information it is to be noted that these vessels' economical range of speed varies approximately between 10½ and 12 knots. In most cases, however, their shaftings do not permit installing powers in excess of 11 knots.

The relationship existing between power, speed, revolutions and size of shafting is illustrated by the sub-joined curves which show the performance of a number of propellers designed according to the Dyson method for the 13,000 d.w.t. cargo vessels of model 1,135, with an allowance of 15% over the tank E.H.P. as previously advocated. In order to make the various propellers strictly comparable their basic slip and power factor were selected so that each propeller would begin cavitating when, by reason of increased resistance, the vessel slows down under the designed speed. Thus, propellers designed for 10 knots would begin cavitating at 9 knots, but will not reach full cavitation until the vessel is slowed down considerably below this latter speed. The practical effect of this method of design results in efficient propellers having a reasonable margin against cavitation, while permitting the higher revolutions so desirable with Diesel propulsion.

Based on the above considerations, curves of shaft horsepower for various speeds were plotted on R.P.M. as abscissae, the increase in revolutions being obtained by a gradual reduction in propeller diameter, attended by correspondingly finer pitch, greater projected area, and gradual falling off in propulsive efficiency as indicated by the rising curves of S.H.P.

The approximate power which can be transmitted by a line shaft of given diameter (d) can be computed by the formula:

$$S.H.P. = \frac{d^3 \times R}{85}$$

and will vary as a straight line when plotted on R.P.M., as shown. (American Bureau shafting rules are on page 69.)

On the other hand the power developed by a Diesel engine operating at a constant mean indicated-pressure also varies approximately as the revolutions, but as the slope of the curve representing the power transmitted by the line shaft is steeper than the curves of S.H.P. required for a given speed, it would appear that a Diesel engine of a certain size could be made to yield greater power, and the vessel's speed consequently increased, by the simple process of increasing the R. P. M., which indeed would be a most desirable way of reducing the weight and cost of a marine Diesel installation.

Unfortunately, however, the necessity of sustaining a reasonable propulsive efficiency at sea, under varying conditions of loading and weather, seldom permit the finer pitch ratios obtaining with high revolutions as we quickly reach a range of propeller proportions contrary to good practice. Thus, for design 1,135, in passing from a 19 foot to a 17.5 foot propeller the pitch ratio decreases from .80 to 0.73, so that the desirable working range for the existing line shafting is limited by the shaded area; conditions obtaining with larger shafting being indicated by the dot and dash lines. In general the smaller the vessel the higher the permissible revolutions and the following may be considered as a guide for the full bodied single-screw vessels available for conversion:

13,000 to 11,000 d. w. t.	80 to 85 R. P. M.
10,000 to 9,000 d. w. t.	85 to 90 R. P. M.
9,000 to 7,500 d. w. t.	90 to 95 R. P. M.
7,000 to 6,000 d. w. t.	95 to 100 R. P. M.
6,000 to 5,000 d. w. t.	100 to 105 R. P. M.
5,000 to 4,000 d. w. t.	105 to 110 R. P. M.

In selecting the power necessary to propel a vessel at a certain speed, it should be remembered that as Diesel engines are manufactured by assembling cylinders of standard dimensions and the principal parts are made interchangeable by accurate machining to expensive jigs, tools and gauges, it is not always possible to meet demands for a limited number of odd sizes, except by developing special designs at much higher costs. Therefore, prospective convertors should confer with the builders and endeavor to use that particular standard size engine that will come nearest to their power requirements and cheerfully accept the incidental plus or minus variation in speed.

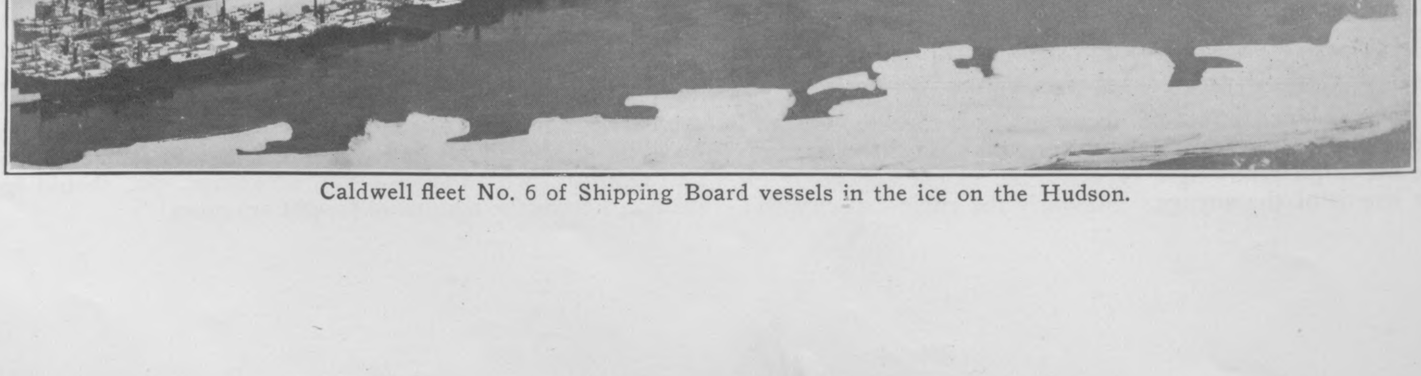
A certain latitude in meeting power requirements differing from developed standard sizes, is afforded by a slight variation in revolutions and by detaching such integral parts of a main engine as compressors and scavenging pumps; driving the same as separate units either directly, by means of auxiliary engines, or through electric motors. Either method, however, will materially increase the auxiliary plant, which by reason of its smaller component parts and higher revolutions can not be possibly made as rugged and reliable as the main engine, not to speak of the increased cost and added complication. These remarks apply strictly to cargo vessels, as for special type such as tankers fitted with electrically driven cargo-oil pumps, or refrigerators having electrically driven refrigerating machinery, the auxiliary generating plant is usually furnished in duplicate and its size may be such as to provide a sufficient margin to also drive independent compressors or scavenging pumps.

After all the two great desiderata of a marine power-plant, particularly for motorships engaged on long voyages and subject to possible sudden defections of engineering personnel, are: simplicity and reliability, which, in the opinion of the author and of most marine engineers, can be secured to a greater degree by the use of conservatively-rated, heavy-duty, long-stroke, direct-connected engines having moderate revolutions.

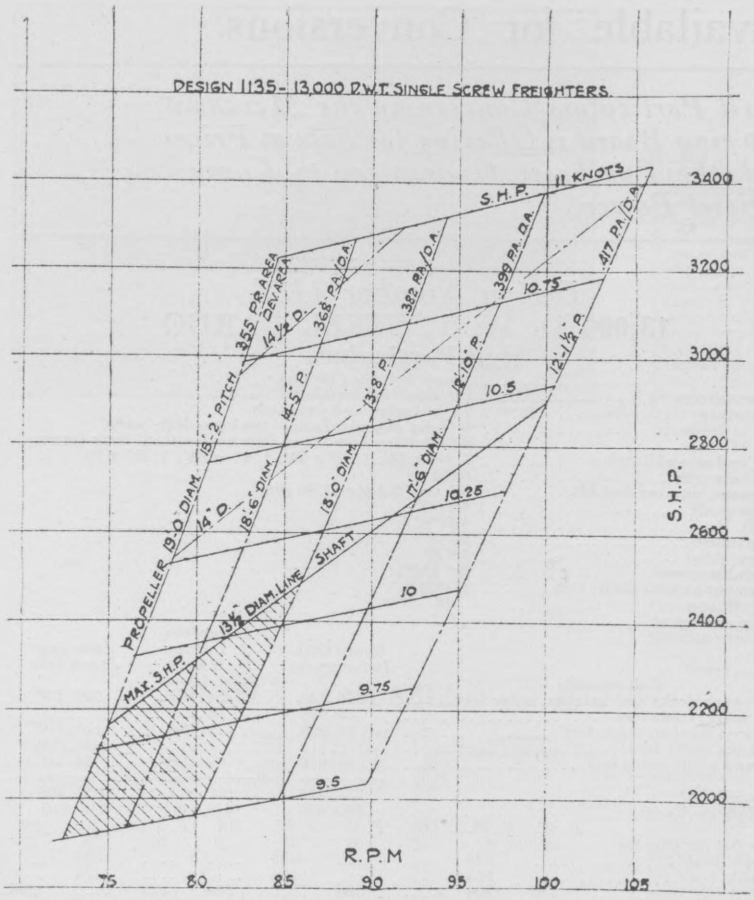
These truisms may prove irksome to some, but on last analysis the establishment of an adequate, privately owned national marine capable of meeting foreign competition on the overseas trades, transcends in importance all engineering fetishisms.

Selection of Auxiliaries.

Coming now to the subject of engine-room and deck auxiliaries, opinions greatly differ as to the most desirable arrangement. In a conversion job, however, the question to decide is whether to retain



Caldwell fleet No. 6 of Shipping Board vessels in the ice on the Hudson.



the existing steam auxiliaries or to install a complete system of electric-driven auxiliaries; the answer largely depends on the character and physical condition of the present steam equipment, the kind of cargo and the requirements of the trade.

If steam auxiliaries are to be retained, those used at sea should be arranged so as to avoid the constant use of an auxiliary-boiler, or the sea fuel-consumption will be materially increased by several tons per day, but whatever the arrangement adopted it will not improve the port fuel consumption. As is well-known, when in port, fuel is consumed in performing a variety of services; for the convenience of those lacking reliable figures the following may serve as a guide in the case of Shipping Board steamers:

Kind of fuel	*Oil*	*Coal*
Fuel per ton of cargo handled, lbs.	7.5	12.0
Fuel per hour, for ship's purposes, lbs.	350	550
Fuel per ton of oil bunkered, lbs.	3	.....

In certain trades a steamer's stand-by consumption is often quite high, as when changing berth or maintaining steam up for emergency purposes, as necessary in certain Oriental ports during the typhoon season. But omitting such special cases, the normal port fuel consumption of an oil-burning steamer will vary from 6 to 12 tons per day, depending on size, number of winches, etc., whereas for a similar motorship with all electric auxiliaries it would vary from ½ to 1 ton per day, or approximately 1/12 that of the steamer.

The question then is whether this saving will off-set the greater cost. Taking for example an 8,560 d.w.t. Robert Dollar type of vessel, the operation of which was analyzed in the preceding tables, the port fuel consumption would average approximately $12,500 per annum less for electrical auxiliaries, and as their installation would cost from $75,000 to $90,000 more, this saving would yield an interest of from 14% to 17% on the investment. This, however, is likely to be improved owing to the higher maintenance cost of steam deck-machinery and piping.

Should it, however, become necessary to operate an oil-fired auxiliary boiler at sea, the daily fuel-consumption would increase at least from 2 to 3 tons; if 180 days are spent at sea each year, with Diesel oil at $14.00 per ton, the additional expense would vary from $5,000 to $7,000 per annum. It appears, therefore, that in most cases the greater cost of electric auxiliaries is amply justified by the savings of operation.

Competitive Value of Converted Vessels.

The question now arises as to whether the reduction of operating expenses obtaining with a converted vessel would be nullified by its high cost. Accordingly, table XII has been prepared to show the estimated cost of converting certain typical Shipping Board steamers, which include drydocking, scaling and painting, but no hull repairs of extraordinary nature, such as changes or improvements to make the vessels more suitable for the various trades. These prices are also based on converting the various types into groups of from 3 to 4 vessels each:

TABLE XII — ESTIMATED DIESEL CONVERSION COSTS OF TYPICAL SHIPPING BOARD STEAMERS

Average dwt.	5,300	7,650	8,650	9,520
No. available for conversion	112	7	136	63
Total dwt.	593,600	52,560	1,175,240	599,790
Total length of machinery spaces	47' 3"	50' 0"	49' 6"	50' 0"
Average service shaft horsepower	1,400	1,900	2,100	2,250
Average service speed, knots	10.5	10	10	10
Engine-room auxiliaries	$14,500	$19,000	$21,000	$23,000
Diesel generators and electrical equipment	39,500	50,000	53,000	55,000
Deck machinery	42,000	43,000	44,000	45,000
Main engine and manoeuvering compr.	154,000	200,000	218,000	230,000
Removal, alterations and installation	60,000	70,000	80,000	85,000
Drydocking, scaling and painting	6,000	7,000	8,000	10,000
Total cost of conversion	$316,000	$389,000	$424,000	$448,000
Approx. cost per s.h.p. of main engines	225	205	202	199
Approx. cost per dwt	60	51	49	47

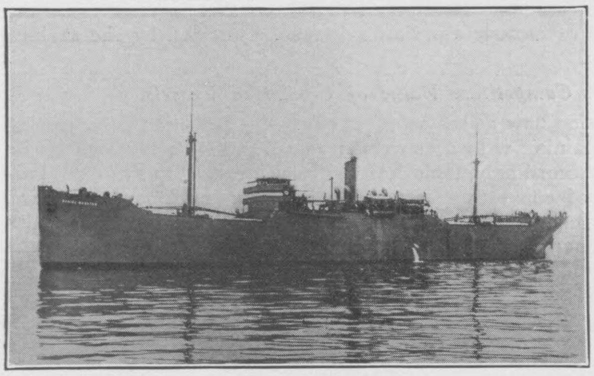
Previous estimates for the 8,560 d.w.t. Robert Dollar type of vessel show an average saving of approximately $70,000 per annum for the motorship over an oil-burner, so that the cost of conversion would be absorbed in a period of from 6 to 7 years. In these estimates, however, we have assumed that equal cargoes are carried, but if the greater potential earning power of the converted vessel is taken into account, this time would be accordingly reduced.

The present price for the best Shipping Board steamers—to be operated as steamers—now vary from approximately $25 to $30 per d.w.t., to which should be added approximately $5 per ton for placing the vessel in commission and effecting a general overhaul. Careful studies indicate that such a steamer could not compete against a converted domestic motorship as long as its total cost of the latter does not exceed $60 to $65 per ton. In gauging the ability of a converted domestic vessel to meet foreign competition, it should be remembered that new foreign steamers can be purchased at from $40 to $45 per d.w.t. and foreign motorships at from $65 to $80 per d.w.t. Therefore, if the conversion cost of a domestic vessel can be kept sufficiently low there will be established a differential that should materially assist in partially offsetting the many handicaps of American ownership and operation.

Staten Island Fleet No. 5 of Shipping Board vessels.

Steel Merchant-Ships Available for Conversions.

On the Following Pages There Are Full Particulars Concerning the Merchant Ships of Various Types which the Shipping Board is Offering for Sale at Prices from $7 to $15 per d.w. Ton Provided the Purchaser Guarantees to Convert Them to Diesel Power.



Design Number 1135

13,000 D. W. T. STEEL CARGO

Hull Particulars

Builder	Pusey & Jones Company
Type of construction	Longitudinal framing
Superstructures	Poop, bridge and forecastle
Number of holds	5 (John Jay and James Otis have deep tanks)
Number of decks	2 (John Jay and James Otis have a third deck forward)
Number and size of hatches	2:36′ x 24′; 1:35′ x 24′; 1:48 x 24′; 1:22′ x 24
Type of bulwarks	Solid
Cargo booms, number and lift	8 5 ton; 2 3 ton; 1 30 ton
Length over all	455′ 0″
Length B. P	439′ 6″
Beam, moulded	60′ 0″
Depth, moulded	36′ 8″
Draft, load summer	28′ 4¾″
Displacement at load draft, tons	17,000
Block coefficient	.806
Prismatic coefficient	.822

Bale capacity	*Henry Clay Indianapolis*	*A. Jackson A. Lincoln D. Webster John Adams*	*John Jay James Otis*
Holds, 'tween decks and hatches, cubic feet	535,738	536,237	526,237
Gross bunker, cubic feet	32,928	26,628	......
Tween deck bunker, cubic feet	19,698	19,698	16,750
Deep tanks, cubic feet	......	......	27,290
Bridge and poop, cubic feet	42,950	47,308	44,740
Grand total	631,314	629,871	615,200
Grain capacity, cu. ft.	660,408	656,868	648,840

	F. W.	S. W.	*Oil	F. W.	S. W.	Oil	F. W.	S. W.	Oil
Cubic feet per long ton	*36*	*35*	*40*	*36*	*35*	*40*	*36*	*35*	*40*
Fore peak, tons	....	235	....	....	235	....	....	235	....
After peak, tons	....	163	....	....	174	....	....	174	....
Inner bottoms, tons	230	1204	....	230	....	944	232	....	990
Wing tanks, aft, tons	....	153	....	....	153	....	....	153	....
Deep tanks, tons	....	....	....	....	....	....	....	946	827
Settling tanks, tons	....	....	....	....	....	38	....	....	42
Total	230	1755	....	230	562	982	232	1508	1859

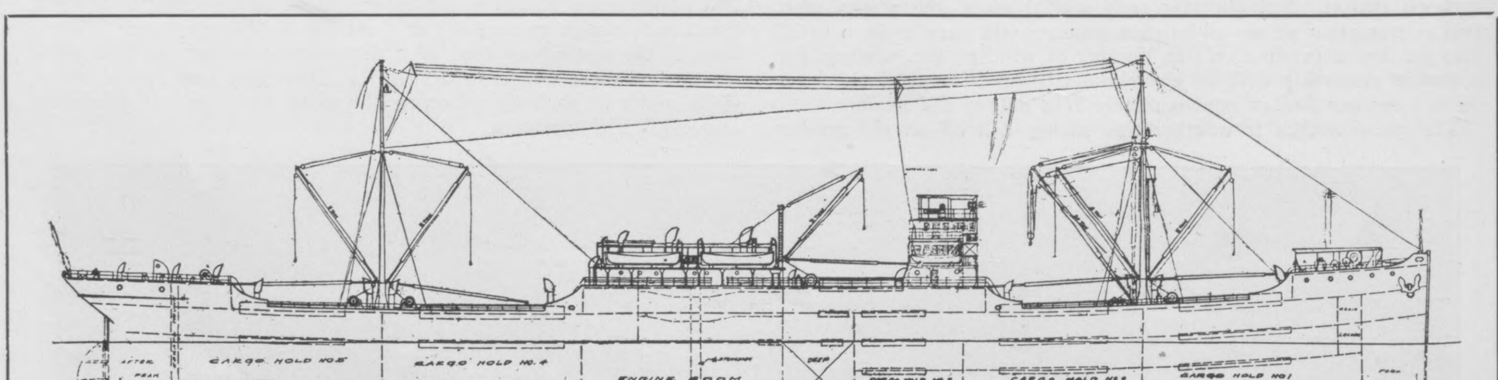
Machinery Particulars

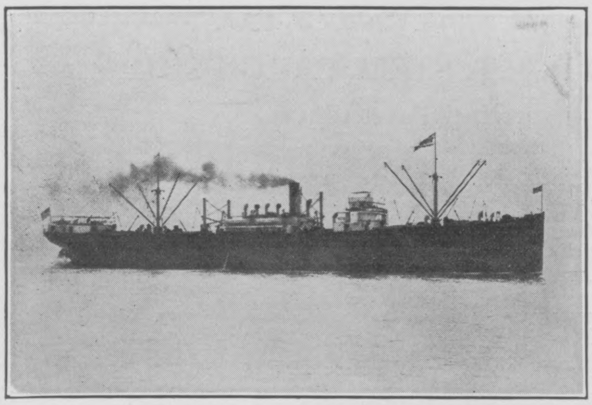
	A. Lincoln A. Jackson D. Webster	*John Adams John Jay James Otis*	*Henry Clay Indianapolis*
Number and type of boiler	3 B. & W.	3 B. & W.	3 S. E. Scotch
Total boiler heating surface	8700	8700	7803
Working pressure, lbs. gauge	200	200	210
Main engine	General Electric Geared Turb.	De Laval Geared Turb.	General Electric Geared Turb.
Designed horsepower and R. P. M.	3000 at 90	2750 at 90	3000 at 90
Designed sea speed, knots	10.5	10.25	10.5
Length of engine and boiler rooms	48′ 0″	48′ 0″	48′ 0″
Diameter and length of propeller shaft	15″ x 15′ 11½″	15″ x 15′ 11½″	15″ x 15′ 11½″
Diameter and length of line shaft	13½″ x 24′ 0″	13½″ x 24′ 0″ 13½″ x 20′ 6½″	13½″ x 18′ 0″
Diameter and length of thrust shaft	14⅜″ x 13′ 6″	14⅜″ x 13′ 6″	14⅜″ x 13′ 6″
Total length of shafting	173′ 5½″	170′ 0″	173′ 5½″
Shaft center above base line, at stern	10′ 6″	10′ 6″	10′ 6″
Shaft center above base line at Eng. Coup'g.	10′ 6″	10′ 6″	10′ 6″
Engine coupling above tank top	6′ 9″	6′ 9″	6′ 9″
Engine coupling from after bulkhead	21″ For'd	20½″ abaft	21″ For'd
Maximum propeller diameter allowed by stern frame	19′ 0″	19′ 0″	19′ 0″

VESSELS AVAILABLE

Name	*D. W. T.*	*Gross*	*Net*	*Date built*	*Location*
Abraham Lincoln	12,980	7,660	4,867	Sept., 1919	Hog Island, Pa.
Indianapolis	12,706	8,134	6,121	Feb., 1918	"
John Jay	12,850	8,292	6,164	June, 1920	"
Andrew Jackson	12,980	7,746	4,926	Nov., 1919	James River, Va.
Daniel Webster	12,980	8,289	6,147	Nov., 1919	"
Henry Clay	12,930	8,166	6,308	May, 1919	"
James Otis	12,850	8,292	6,168	July, 1920	"
John Adams	12,980	7,809	4,969	Oct. 1919	"

* Fitted with deep tanks and third deck in forward holds.





Design Number 1032

11,800 D. W. T. STEEL CARGO

Hull Particulars

Builder	Bethlehem Shipbuilding Corporation, Ltd.
Type of construction	Longitudinal framing
Superstructures	Shelter deck
Number of holds	5 and deep tanks
Number of decks	2
Number and size of hatches	3:20′ x 30′; 1:10′ x 20′; 1:20′ x 15′; 1:20′ x 20′
Type of bulwarks	Rail
Cargo booms, number and lift	4 3 ton; 8 5 ton; 1 30 ton
Length overall	457′ 6″
Length B. P.	440′ 1½″
Beam, moulded	56′ 0″
Depth, moulded	38′ 0″
Draft, load summer	28′ 7½″
Displacement at load draft	15,946 tons
Block coefficient	.808
Prismatic coefficient	.825
Bale capacity, holds, 'tween decks and hatches	560,996 cubic feet (including 15,000 cu. ft. midship 'tween decks)
Bale capacity, deep tanks	24,613 cubic feet
Total bale capacity	585,609 cubic feet
Total grain capacity	615,891 cubic feet

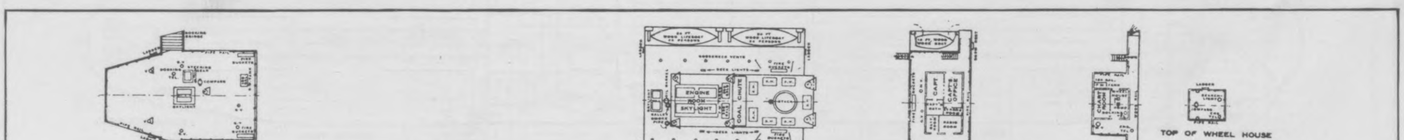
Cubic feet per long ton	*Fresh water* *36*	*Salt water* *35*	*Fuel oil* *40*
Fore peak, tons	....	138	...
After peak, tons	...	160	...
Inner bottoms, tons	179	...	1,202
Deep tanks	...	910	...
Settling tanks	...	...	63
Total	179	1,208	1,265

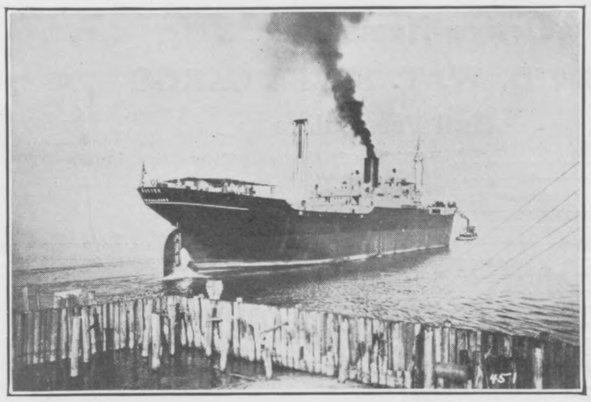
VESSELS AVAILABLE

Name	*D. W. T.*	*Gross*	*Net*	*Date built*	*Location*
Courageous	11,868	7,593	4,755	Dec., 1918	James River, Va.
Triumph	11,868	7,588	4,854	Jan., 1919	"
Defiance	11,773	7,611	4,786	Sept., 1918	"

Machinery Particulars

Number and type of boilers	3 single end, Scotch
Total boiler heating surface	8,250 sq. ft.
Working pressure, lbs. gauge	215
Main engine	Single turbine geared — General Electric
Designed H. P. and R. P. M.	3,000 S. H. P. at 90
Designed sea speed, knots	10.5
Length of engine and boiler rooms	55′ 0″
Diameter and length of propeller shaft	15″ x 21′ 4″
Diameter and length of line shaft	14″ x 23′ 0″
Diameter and length of thrust shaft	15″ x 10′ 10″
Total length of shafting	193′ 2″
Shaft center above base line, at stern	10′ 9″
Shaft center above base line, at Eng. coupling	10′ 9″
Engine coupling above tank top	7′ 0″
Engine coupling from after bulkhead	4′ 2½″ for'd
Maximum propeller diam. allowed by stern frame	19′3″





Design Number 1037

9,800 D.W.T. STEEL CARGO SHIP

Hull Particulars

Builders	Carolina S. B. Co.— Doullut & Williams S. B. Co.
Type of construction	Longitudinal
Superstructures	Poop, bridge and forecastle
Number of holds	5.
Number of decks	2.
Number and size of hatches	4: 31′ 4″ x 17′ 6″ — 1: 10′ 0″ x 17′ 6″
Type of bulwarks	Solid
Cargo booms, number and lift	10 5 ton; 1 30 ton
Length over all	412′ 3″
Length B. P.	395′ 6″
Beam, moulded	55′ 0″
Depth, moulded	34′ 11″
Draft, load summer	27′ 0½″
Displacement at load draft	13,141 tons
Block coefficient	.795
Prismatic coefficient	.808
Bale capacity, cargo holds	421,504 cubic feet
Bale capacity, bridge	31,241 cubic feet
Bale cargo, total	452,745 cubic feet
Grain capacity, total	476,120 cubic feet

	Fresh water	*Salt water*	*Fuel oil*
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	...	195	..
After peak, tons	...	187	..
Inner bottoms, tons	258	...	1,118
Settling tanks, tons	...	...	71
Total, tons	258	382	1,189

VESSELS AVAILABLE

Carolina S.S. Co.

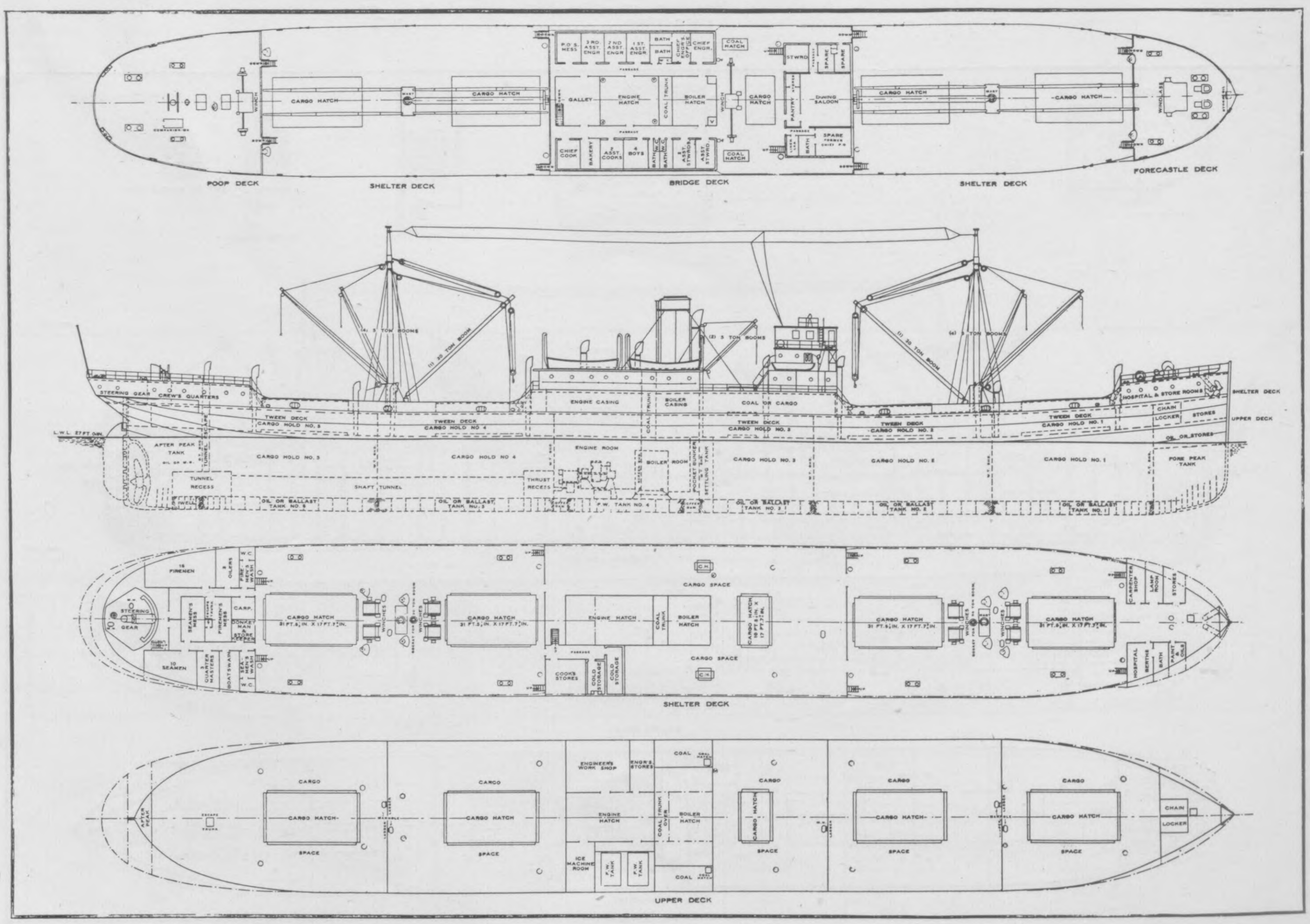
Name	*D. W. T.*	*Gross*	*Net*	*Date built*	*Location*
City of Joliet	9,773	6,501	4,016	Aug., 1920	Arlington, S. I.
Nemaha	9,773	6,501	4,016	June, 1920	"
City of Omaha	9,770	6,527	4,049	Feb., 1920	Jones Point, N. Y.
City of Fort Worth	9,773	6,501	4,016	Aug., 1920	James River, Va.
Hybert	9,773	6,501	4,016	Sept., 1920	"
Syros	9,773	6,501	4,016	Oct., 1920	"
Cranford	9,751	6,527	4,049	Jan.. 1920	Operating.
Winston-Salem	9,773	6,223	3,843	Apr., 1920	"

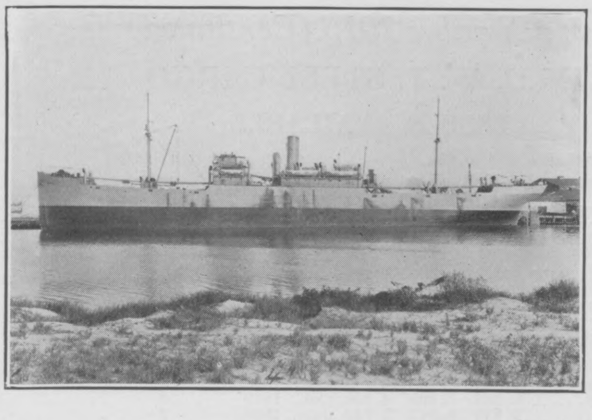
Doullut & Williams S. B. Co.

Name	*D. W. T.*	*Gross*	*Net*	*Date built*	*Location*
New Orleans	9,724	6,171	3,797	Oct., 1920	James River, Va.
City of Elwood	9,680	6,171	3,797	Apr., 1921	"
Galveston	9,620	6,171	3,797	Apr., 1921	"
Oldham	9,649	6,171	3,797	June, 1921	"
Potter	9,680	6,631	4,110	Dec., 1920	"
Wichita	9,705	6,171	3,797	Mar., 1921	"
Jeff Davis	9,678	6,171	3,797	Apr., 1921	Operating.

Machinery Particulars

	Carolina S. B. Co.	*Doullut & Williams*
Number and type of boiler	3 Foster W. T.	3 Foster W. T.
Total boiler heating surface, square feet	9,150	9,150
Working pressure, lbs. gauge	225	225
Main engine	Tr. Exp., H. O. R.	Parsons Geared
Designed H. P. and R. P. M.	2500 I. H. P. @ 78	2800 S. H. P. @ 90
Designed sea speed, knots	10.5	11
Length of engine and boiler rooms	52′ 6″	52′ 6″
Diameter and length of propeller shaft	15¼″ x 18′ 5¼″	14¼″ x 20′ 1″
Diamater and length of line shaft	6 13¼″ x 20′ 6″	7 13″ x 17′ 6″
Diameter and length of thrust shaft	....	1 13″ x 14′ 0″
	14″ x 12′ 9⅜″	....
Total length of shafting	154′ 2⅝″	153′ 1″
Shaft center above base line, at stern	10′ 0″	10′ 0″
Shaft center above base line, at Eng. Coupl'g	9′ 1⅜″	11′ 0″
Engine coupling above tank top	4′ 10⅜″	7′ 9 11-16″
Engine coupling from after bulkhead	34½″ for'd	27″ for'd
Maximum propeller diam. with present stern frame	17′ 9″	17′ 9″





Design Number 1027

9,500 D. W. T. STEEL CARGO

Hull Particulars

Builder	Oscar Daniels Company
Type of construction	Longitudinal framing
Superstructures	Bridge, forecastle and poop
Number of holds	5 and deep tanks
Number of decks	2
Number and size of hatches	2:18′ x 36′ 8″; 1:18′ x 43′; 1:18′ x 22′; 1:18′ x 10′ 6″
Type of bulwarks	Solid
Cargo booms, number and lift	8:5 ton; 2:3 ton; 1:30 ton
Length overall	416′ 0″
Length B. P.	402′ 0″
Beam, moulded	54′ 0″
Depth, moulded	33′ 9″
Draft, load summer	26′ 10¾″
Displacement at load draft	12,910 tons
Block coefficient	.801
Prismatic coefficient	.808
Bale capacity, holds, 'tween decks and hatches	413,090 cubic feet (including 12,883 cu. ft. midship 'tween decks)
Bale capacity, deep tanks	32,444 cubic feet
Bale capacity, bridge and poop	41,176 cubic feet
Total bale capacity	486,710 cubic feet
Total grain capacity	515,888 cubic feet

Cubic feet per long ton	*Fresh water* *36*	*Salt water* *35*	*Fuel oil* *40*
Fore peak, tons	—	108	...
After peak, tons	...	63	...
Inner bottoms, tons	164	...	794
Deep tanks, tons	...	1,051	...
Settling tanks, tons	...	...	51
Total	164	1,222	845

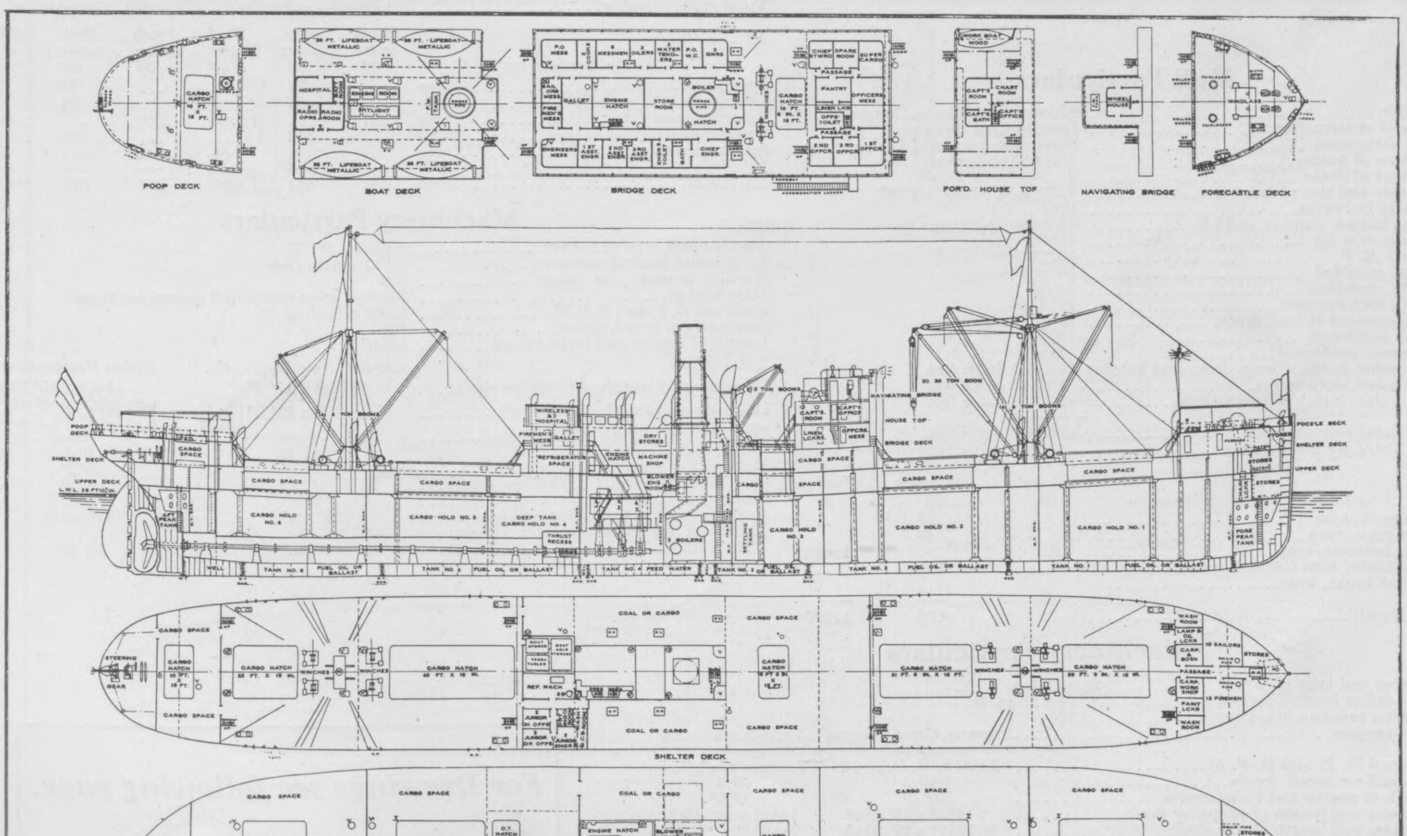
VESSELS AVAILABLE

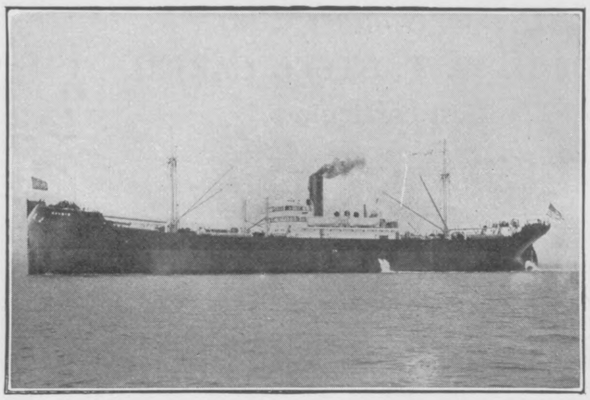
Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
Seminole	9,569	5,984	3,847	Mar., 1920	Arlington, S. I.
City of Dalhart	9,524	5,135	3,127	Mar., 1921	James River, Va.
City of Rayville	9,559	6,368	4,108	Jan., 1921	"
Manatee	9,569	5,348	3,823	July, 1920	"
Sawokla	9,539	5,984	3,847	Oct., 1920	"
Unicoi	9,518	5,926	3,808	Mar., 1920	"
***Yomachichi**	9,522	7,225	4,665	Oct., 1919	"
***Tampa**	9,444	5,940	3,823	Feb., 1920	"
***Wilscox**	9,497	5,926	3,808	Dec., 1919	Mobile, Ala.

* Badenhausen Boilers, 9,630 sq. ft. heating surface.

Machinery Particulars

Number and type of boilers	3 Foster, W. T. (except as noted)
Total boiler heating surface	9,150 square feet.
Working pressure, pounds gauge	200
Main engine	$24\frac{1}{2}$″–$41\frac{1}{2}$″–72″ x 48′
Designed H. P. and R. P. M.	2,500 I. H. P. at 78
Designed sea speed, knots	10.5
Length of engine and boiler rooms	52′ 0″
Diameter and length of propeller shaft	14½″ x 18′ 1⅞″
Diameter and length of line shaft	6:13″ x 18′ 0″; 1:13″ x 10′ 0″
Diameter and length of thrust shaft	13¾″ x 17′ 9″
Total length of shafting	153′ 10⅞″
Shaft center above B. L. at stern	9′ 10″
Shaft center above B. L. Eng. Coupl'g	8′ 1 5-16″
Engine coupling above tank top	4′ 5 5-16″
Engine coupling from after bulkhead	2′ 0″ for'd
Maximum propeller diameter allowed by stern frame	18′ 6″





Design Number 1015

9,400 D. W. T. STEEL CARGO

VESSELS AVAILABLE

Name	*D. W. T.*	*Gross*	*Net*	*Date built*	*Location*
Chipchung	9,250	6,163	4,630	June, 1919	James River, Va.
Quillwark	9,416	6,034	4,445	June, 1920	“
Tuckanuck	9,410	6,001	4,148	July, 1919	“
Mulpua	9,250	6,139	4,604	June, 1919	Hog Island, Pa.
Aniwa	9,330	6,012	4,462	July, 1918	Jones Point, N. Y.
Keketticut	9,330	6,072	3,740	April, 1919	“
Naugus	9,432	6,037	4,446	June, 1919	“
Nokatay	9,410	6,036	4,515	Sept., 1919	“
Alloway	9,330	6,113	4,383	July, 1918	Seattle, Wash.
Zirkel	9,330	6,073	4,427	Sept., 1918	Arlington, S. I.
Kamesit	9,248	6,070	4,412	Jan., 1919	Operating.

Hull Particulars

Builder	Moore Shipbuilding Company
Type of construction	Longitudinal framing
Superstructures	Forecastle, poop and bridge house
Number of holds	4 and deep tanks
Number of decks	2
Number and size of hatches	4:20′ x 33′; 1:20′ x 7′ 8″
Type of bulwarks	Rail
Cargo booms, number and lift	10-3 ton; 1-30 ton
Length over all	416′ 6″
Length B. P.	402′ 6″
Beam, moulded	53′ 0″
Depth, moulded	34′ 6″
Draft, load summer	26′ 4¾″
Displacement at load draft	12,625 tons
Block coefficient	.801
Prismatic coefficient	.811
Bale cubic, holds, t'ween decks and hatches	421,744 cubic feet
Bale cubic, deep tanks	18,485 cubic feet
Bale cubic, midship 'tween decks	16,448 cubic feet
Total bale capacity	456,677 cubic feet
Total grain capacity	490,793 cubic feet

Cubic feet per long ton	*Fresh water 36*	*Salt water 35*	*Fuel oil 40*
Fore peak, tons	..	73	..
After peak, tons	..	49	..
Inner bottoms, tons	81	..	1,060
Deep tanks, tons (ballast or oil)	..	546	..
Settling tanks, tons	..	..	37
Total	81	668	1,097

Machinery Particulars

Number and type of boiler	4 Heine, W. T.	
Total boiler heating surface	11,132 sq. ft.	
Working pressure, lbs. gauge	225	
Main engines	Parsons Cross comp'd geared turb.	Various see below
Designed H. P. and R. P. M.	2,800 S. H. P. at 90	Various, see below
Designed sea speed, knots	10.5	10.5
Length of engine and boiler rooms	50′ 0″	50′ 0″
Diameter and length of propeller shaft	14¾″ x 16′ 2¾″	14¾″ x 16′ 2¾″
Diameter and length of line shaft	8:13¼″ x 17′ 8⅝″	7:13⅜″ x 18′ 7″
Diameter and length of thrust shaft	None	13⅜″ x 11′ 1″
Total length of shafting	157′ 11¾″	157′ 4¾″
Shaft center above base line at stern	9′ 2″	9′ 2″
Shaft center above base line at engine coupling	9′ 2″	9′ 2″
Engine coupling above tank top	5′ 7″	5′ 7″
Engine coupling from after bulkhead	2′ 9″ for'd	2′ 2″ for'd
Maximum propeller diam. allowed by stern frame	16′ 9″	16′ 9″

Design Number 1015 (Continued)

9,400 D. W. T. STEEL CARGO

VESSELS AVAILABLE

Seattle North Pacific S. B. Co.

Name	*D. W. T.*	*Gross*	*Net*	*Date built*	*Location*
Manham	9,491	6,030	4,456	Dec., 1919	Jones Point, N. Y.
Yaklok	9,516	6,046	4,426	July, 1919	“
Chicomico	9,511	6,032	4,457	Nov., 1919	Hog Island, Pa.
Osaqumsick	9,498	6,034	4,483	July, 1919	Tottenville, S. I.
Ashawake	9,492	6,148	4,617	July, 1919	James River, Va.
Chepadoa	9,507	6,035	4,475	Oct., 1919	“
Orani	9,507	6,040	4,506	Sept., 1919	“
Ozette	9,519	6,078	4,490	April, 1919	“
Maquam	9,513	6,031	4,453	Aug., 1919	Mobile, Ala.

Union Construction Company

Name	*D. W. T.*	*Gross*	*Net*	*Date built*	*Location*
City of Berkeley	9,488	6,039	3,746	Jan., 1920	Jones Point, N. Y.
Hathaway	9,488	5,991	4,434	Oct., 1919	“
Haymon	9,488	6,042	3,742	July, 1920	“
Hatchie	9,488	5,989	4,431	Aug., 1919	Arlington, S. I.
Hayden	9,488	6,042	3,746	June, 1920	“
Hawarden	9,488	6,042	3,745	April, 1920	James River, Va.
Haxtum	9,488	6,041	3,746	May, 1920	“
Havilah	9,488	6,045	3,745	Mar., 1920	San Francisco, Calif.
Haynie	9,488	6,037	3,754	Aug., 1920	San Francisco, Calif.
Heber	9,488	6,042	3,746	Sept., 1920	San Francisco, Calif.

Hull Particulars

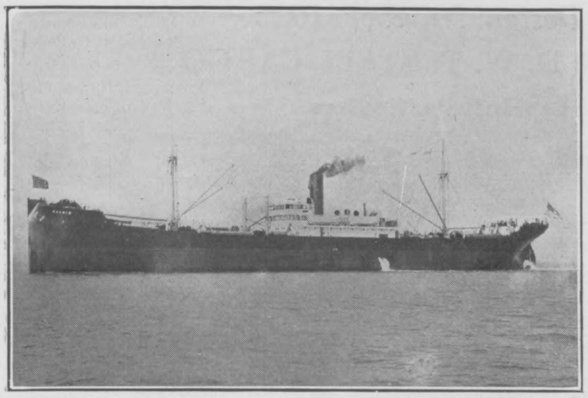
Builders	Seattle Northern Pacific S. B. Co.	Union Construction Co.
Type of construction	Longitudinal framing	
Superstructures	Forecastle, poop and bridge house	
Number of holds	4 and deep tanks	
Number of decks	2	
Number and size of hatches	Seattle N.P. 4-20′ x 33′; 1-20′ x 8′ 6″	Union Constr. 3-20′ x 36′ 8″; 1 20′ x 33′; 1-20′ x 9′
Type of bulwarks	Rail	
Cargo booms, number and lift	2:3-ton; 8:5-ton; 1:30-ton	
	Seattle No. Pacific S. B. Co.	*Union Construction Co.*
Length overall	416′ 10″	416′ 6″
Length B. P.	402′ 6″	402′ 6″
Beam, moulded	53′ 0″	53′ 0″
Depth, moulded	34′ 6″	34′ 6″
Draft, load summer	26′ 5½″	26′ 6″
Displacement at load draft	12,708 tons	12,608 tons
Block coefficient	.802	.802
Prismatic coefficient	.813	.813
Bale capacity, holds, hatches and 'tween decks	423,282 cubic feet	423,907 cubic feet
Bale capacity, deep tanks	Coal or grain	15,713 cubic feet
Bale capacity, midship 'tween decks	15,556 cubic feet	14,892 cubic feet
Total bale capacity	438,838 cubic feet	454,512 cubic feet
Total grain capacity	490,361 cubic feet	490,766 cubic feet

Cubic feet per long ton		*Fresh water 36*	*Salt water 35*	*Fuel oil 40*	*Fresh water 36*	*Salt water 35*	*Fuel oil 40*
Fore peak	tons	...	74	...	...	73	...
After peak	tons	...	55	...	...	51	...
Inner bottoms	tons	81	...	1,042	208	...	940
Deep tanks (ballast or oil)	tons	...	552	...	...	552	...
Settling tanks	tons	...	...	38	...	...	38
Total	tons	81	681	1,080	208	676	978

Machinery Particulars

Number and type of boilers	3 Foster W. T.	
Total boiler heating surface	9,150 square feet	
Working pressure, lbs. gauge	200	
Main engine	Parsons cross compound geared turbines	
Designed H.P. and R.P.M.	2,800 S.H.P. at 90	
Designed sea speed, knots	10.5	
Length of engine and boiler rooms	50′ 0″	
	Seattle No. Pacific Co.	*Union Construction Co.*
Diameter and length of propeller shaft	14⅜″ x 17′ 2″	14 9/16″ x 16′ 2 3/16″
Diameter and length of line shaft	6:13″ x 23′ 3″	7:13⅜″ x 18′ 6″; 1:13⅜″ x 12′ 3 7-16″
Diameter and length of thrust shaft	None	None
Total length of shafting	156′ 8″	158′ 0 3/16″
Shaft center above B.L. at stern	9′ 2″	9′ 2″
Shaft center above B.L. Eng. coupling	9′ 2″	9′ 2″
Engine coupling above tank top	5′ 7″	5′ 7″
Engine coupling from after bulkhead	26″ for'd.	33″ for'd.
Maximum propeller diameter allowed by stern frame	16′ 6″	16′ 6″

For Drawings see following page.



Design Number 1015 (Continued)
9,400 D. W. T. STEEL CARGO
Hull Particulars

Builders	Groton Iron Works — Virginia Shipbuilding Corp.
Type of construction	Longitudinal framing
Superstructures	Forecastle, poop and bridge house
Number of holds	4 and deep tanks
Number of decks	2
Number and size of hatches	4:20′ x 33′—1:20′ x 8′
Type of bulwarks	Rail
Cargo booms, number and lift	Groton: 8-5 ton; 2-3 ton; 1-30 ton. Virginia: 10-3 ton; 1-30 ton
Length overall	416′ 6″
Length B. P	402′ 6″
Beam, moulded	53′ 0″
Depth, moulded	34′ 5″
Draft, load summer	26′ 4¾″
Displacement at load draft	12,625 tons
Block coefficient	.801
Prismatic coefficient	.811

	Groton Iron Works	*Virginia S. B. Co.*
Bale cubic, holds, 'tween decks & hatches	415,641 cubic feet	414,383 cubic feet
Bale cubic, deep tanks	19,558 cubic feet	Ballast or oil only, cubic feet
Bale cubic, midship 'tween decks	9,663 cubic feet	15,589 cubic feet
Total bale capacity	444,862 cubic feet	429,972 cubic feet
Total grain capacity	461,274 cubic feet	464,767 cubic feet

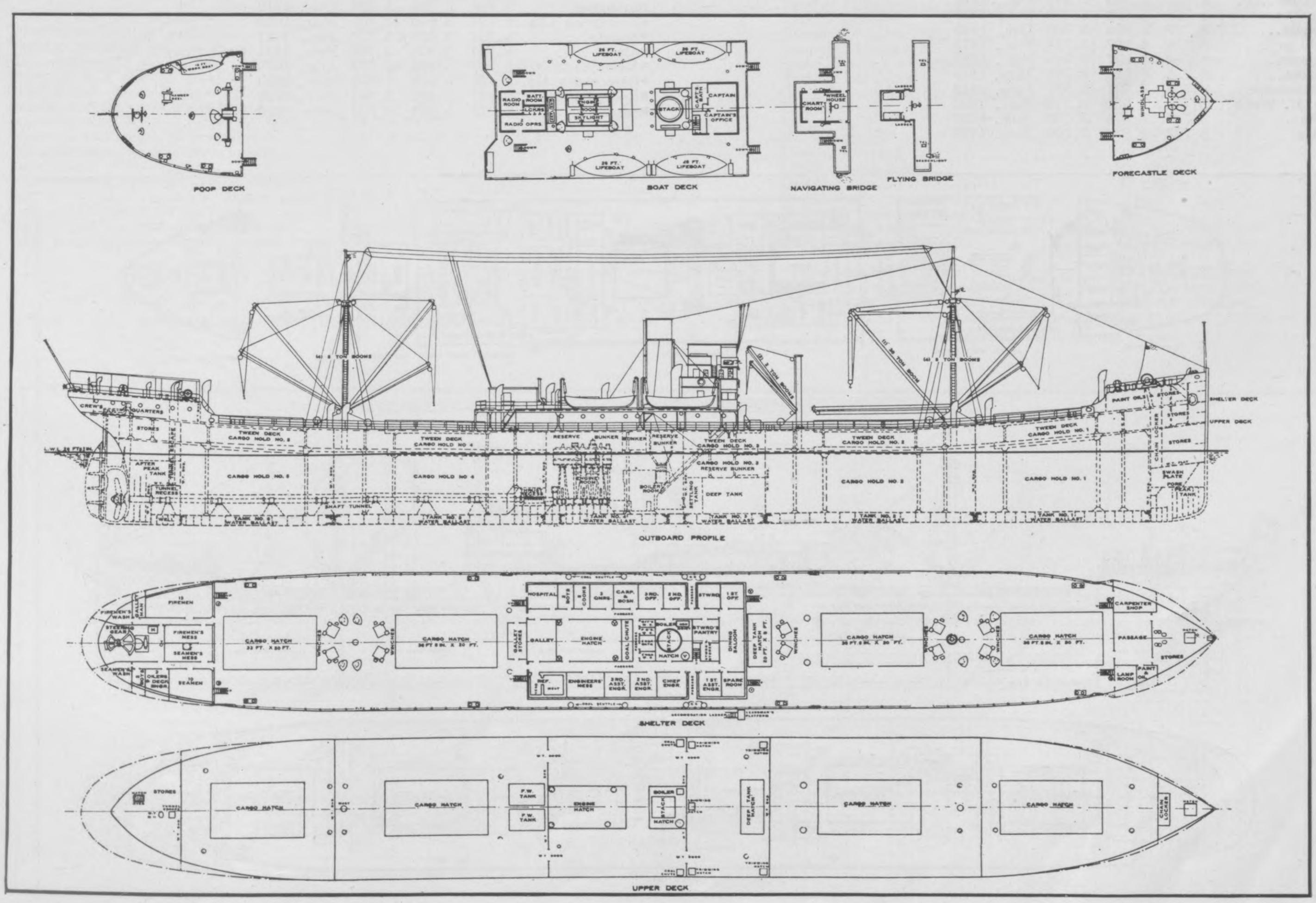
Cubic feet per long ton	*Fresh water 36*	*Salt water 35*	*Fuel oil 40*	*Fresh water 36*	*Salt water 35*	*Fuel oil 40*
Fore peak tons	...	72	...	...	73	..
After peak tons	...	51	...	...	46	..
Inner bottoms tons	251	...	894	80	...	1,067
Deep tanks (ballast or oil) tons	...	584	...	...	587	..
Settling tanks tons	...	...	75	...	...	38
Total tons	251	707	969	80	706	1,105

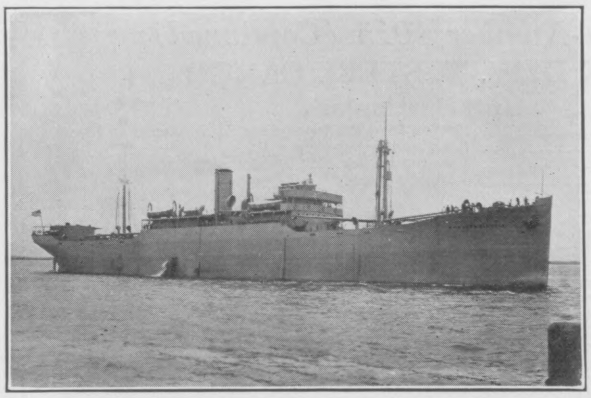
VESSELS AVAILABLE

Name	*D. W. T.*	*Gross*	*Net*	*Date built*	*Location*
Honnedaga	9,400	6,216	3,805	July, 1920	Jones Point, N. Y.
Hopatcong	9,400	6,216	3,805	Dec., 1920	"
Provincetown	9,400	6,216	3,805	Oct., 1920	"
Betsy Bell	9,455	6,059	3,752	Aug., 1919	James River, Va.
Gunston Hall	9,455	6,182	3,841	June, 1919	"
H. F. Morse	9,455	6,054	3,715	Oct., 1919	"
Vanada	9,455	6,059	3,752	Sept., 1919	"

Machinery Particulars

	Groton Iron Works	*Virginia S. B. Co.*
Number and type of boilers	3 Heine, W. T.	4 Heine, W. T.
Total boiler heating surface	9,510 sq. ft.	11,208 sq. ft.
Working pressure, lbs gauge	195	200
Main engine	Parsons Cross Com'd geared turb.	24½″ 41½″ 72″ x 48″
Designed H. P. and R. P. M.	2,800 S. H. P. @ 90	2,500 I. H. P. @ 78
Designed sea speed, knots	10.5	10.25
Length of engine and boiler rooms	50′ 0″	50′ 0″
Diameter and length of propeller shaft	14½″ x 16′ 2″	14½″ x 16′ 2¾″
Diameter and length of line shaft	7:13″ x 18′ 7″	6:13¼″ x 18′ 7″; 1:13¼″ x 16′ 10⅜″
Diameter and length of thrust shaft	14⅜″ x 10′ 11″	14″ x 12′ 9⅜″
Total length of shafting	157′ 3″	157′ 4¾″
Shaft center above base line at stern	9′ 2″	9′ 2″
Shaft center above base line, at engine coupling	9′ 2″	9′ 2″
Engine coupling above tank top	5′ 7″	5′ 7″
Engine coupling from after bulkhead	24″ for'd	26″ for'd
Maximum propeller diameter allowed by stern frame	17′ 3″	17′ 3″





Design Number 1025

8,800 D. W. T. STEEL CARGO

Hull Particulars

Builder	Merchants Shipbuilding Corporation	
Type of construction	Transverse, fabricated	
Superstructures	Poop, bridge and forecastle	
Number of holds	5 (4 where deep tanks are fitted)	
Number of decks	2	
Number and size of hatches	4:29′ 3″ x 20′; 1: 18′ x 20′	
Type of bulwarks	Solid	
Cargo booms, number and lift	10 5-ton; 1 30-ton	
Length overall	417′ 8½″	
Length B.P.	401′ 0″	
Beam, moulded	54′ 0″	
Depth, moulded	32′ 10″	
Draft, load summer	25′ 2″	
Displacement at load draft, tons	12,225	
Block coefficient	.804	
Prismatic coefficient	.817	
Bale cubic: holds, 'tween decks and hatches	388,448 cubic feet	362,625 cubic feet
Bale cubic: deep tanks	none	27,400 cubic feet
Bale cubic: bridge	39,411 cubic feet	37,755 cubic feet
Total bale capacity	427,859 cubic feet	427,780 cubic feet
Bale cubic: midship 'tween decks	13,920 cubic feet	13,920 cubic feet
Total grain capacity	481,400 cubic feet	481,500 cubic feet

		Fresh water	*Salt water*	*Fuel oil*	*Fresh water*	*Salt water*	*Fuel oil*
Cubic feet per long ton		*36*	*35*	*40*	*36*	*35*	*40*
Fore peak	tons	...	120	....	...	120	....
After peak	tons	143	...	....	143	....	....
Inner bottoms	tons	137	...	1,024	137	....	1,024
Deep tanks (ballast or oil)	tons	...	None	....	...	846	....
Settling tanks	tons	...	...	59	...	....	59
Total	tons	280	120	1,083	280	966	1,083

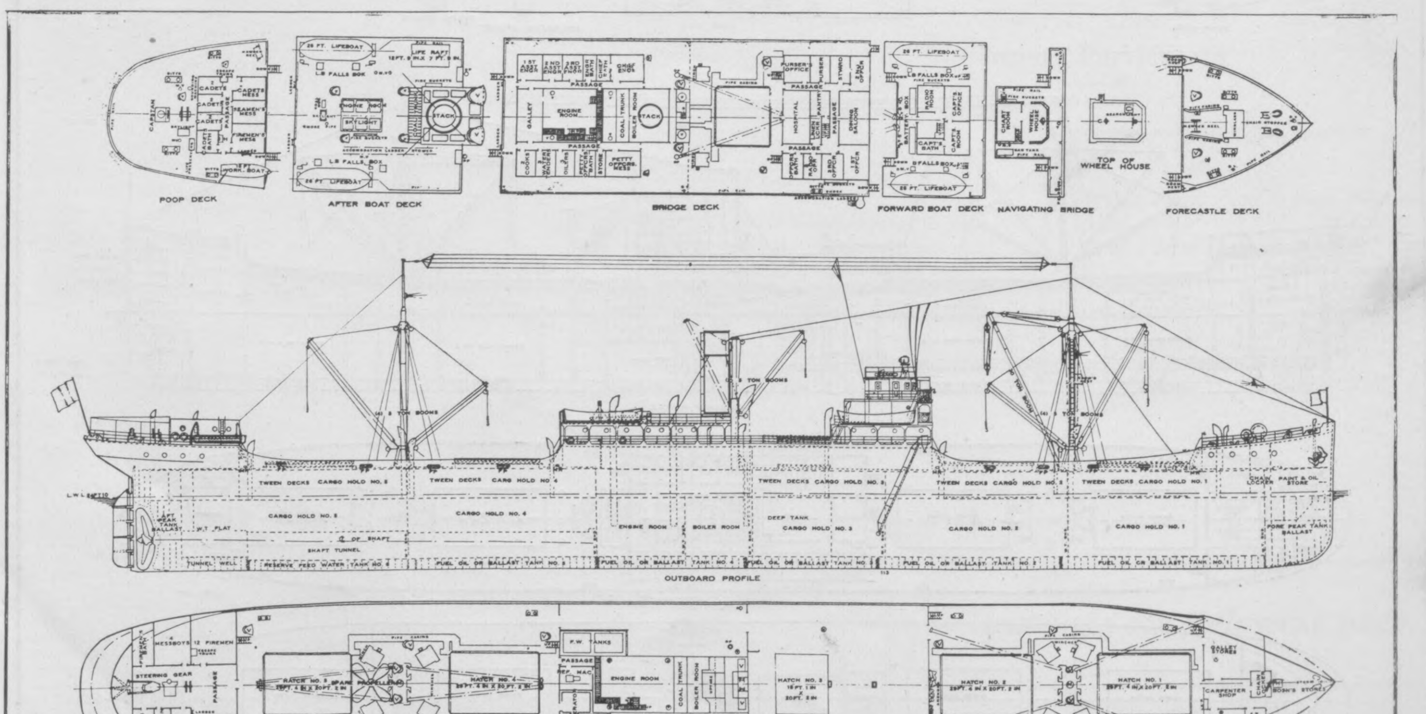
Machinery Particulars

Number and type of boilers	3 Foster, W. T.	3 Babcock & Wilcox, W.T.
Total boiler heating surface	9,459 square feet	8,700 square feet
Working pressure, pounds gauge	200	200
Main engines	Westinghouse cross compound geared turbines	
Designed H.P. and R.P.M.	2,500 S.H.P. at 90	3,000 S.H.P. at 90
Designed sea speed, knots	10	
Length of engine and boiler rooms	51′ 9″	
Diameter and length of propeller shaft	14¾ x 17′ 6¼	
Diameter and length of line shaft	6:13¼″ x 23′ 2″	
Diameter and length of thrust shaft	None	
Total length of shafting	156′ 6¼″	
Shaft center above base line at stern	10′ 9″	
Shaft center above base line at eng. coupl'g.	9′ 3″	
Engine coupling above tank top	5′ 7″	
Engine coupling from after bulkhead	3′ 6″ for'd	
Max. propeller diam. allowed by stern frame	19′ 9″	

VESSELS AVAILABLE

Name	*D. W. T.*	*Gross*	*Net*	*Date built*	*Location*
***Henry Steers**	8,736	5,980	3,713	April, 1920	Jones Point, N, Y.
***John Roach**	8,736	5,980	3,713	Dec., 1919	"
Neshaminy	8,756	6,126	3,800	July, 1919	"
Watonwan	8,756	5,467	3,308	Jan., 1919	"
Wynooche	8,756	6,056	3,756	April, 1919	"
Cabegon	8,756	6,107	3,755	Feb., 1919	Arlington, S. I.
***Davenport**	8,727	5,491	3,370	Mar., 1919	"
***Chester Kiwanis**	8,736	5,502	3,393	June, 1920	Tottenville, S. I.
Intan	8,756	5,490	3,374	June, 1919	"
Lycoming	8,756	5,989	3,709	Nov., 1919	"
***Yapalaga**	8,727	5,976	3,700	Oct., 1920	"
Winyah	8,756	5,492	3,376	July, 1919	"
***Amcross**	8,736	5,980	3,713	Dec., 1919	Hog Island, Pa.
***Arizpa**	8,727	5,517	3,392	Oct., 1920	"
***Bonnie Brook**	8,727	5,976	3,700	Oct., 1920	"
Costigan	8,756	6,126	3,800	July, 1919	"
***Delanson**	8,727	5,989	3,709	Feb., 1920	"
Epitacio Pessoa	8,756	5,989	3,707	Sept., 1919	"
***Gateway City**	8,727	5,976	3,700	Sept., 1920	"
***Geo. E. Weed**	8,747	5,975	3,710	Oct., 1920	"
***John Englis**	8,747	5,975	3,710	Aug., 1920	"
***Naamhok**	8,727	5,976	3,700	Jan., 1921	"
***Waterbury**	8,727	5,510	3,387	June, 1920	"
Wauconda	8,756	5,423	3,345	April, 1919	"
***Arden**	8,727	5,976	3,700	Feb., 1921	James River, Va.
Bensalem	8,756	5,513	3,389	Oct., 1919	"
***City of Alma**	8,727	5,530	3,401	Feb., 1920	"
***Donald McKay**	8,736	5,535	3,415	June, 1920	"
***Greenland**	8,736	5,502	3,383	Mar., 1919	"
***Iceland**	8,736	5,460	3,365	Nov., 1919	"
***John Stevens**	8,747	5,975	3,710	Sept., 1920	"
Kayseeka	8,756	5,989	3,709	Dec., 1919	"
Kittegaun	8,756	5,989	3,709	Aug., 1919	"
***Lansdowne**	8,736	5,479	3,378	Nov., 1919	"
***Loretta**	8,736	5,493	3,382	June, 1919	"
Mercer Victory	8,756	5,500	3,381	Sept., 1919	"
***Mitchell**	8,727	5,510	3,387	Dec., 1919	"
Texarkana	8,736	5,498	3,387	Oct., 1919	"
Wacosta	8,727	5,976	3,700	Dec., 1920	"
Wathena	8,756	6,107	3,744	Feb., 1919	"
Waubesa	8,756	6,107	3,744	Feb., 1919	"
Waukau	8,756	6,126	3,796	May, 1919	"
Waxahatchie	8,756	5,497	3,379	June, 1919	"
Wm. H. Webb	8,736	5,980	3,713	Feb., 1920	"
***Yaka**	8,727	5,976	3,700	Aug., 1920	"
***Yalza**	8,727	5,976	3,700	Nov., 1920	"
Auditor	8,756	5,503	3,383	Oct., 1919	New Orleans, La.
Bavington	8,756	5,539	3,396	Dec., 1919	"
***Evergreen City**	8,727	5,990	3,709	May, 1920	"
***Nacata**	8,727	5,976	3,700	Jan., 1921	"
***Ala**	8,727	5,976	3,700	Feb., 1921	Operating.
***Algic**	8,727	5,496	3,373	Aug., 1920	"
***Emergency Aid**	8,727	5,976	3,700	Nov., 1920	"
***George Pierce**	8,747	5,462	3,365	Nov., 1920	"
***Salaam**	8,727	5,990	3,709	July, 1920	"

* Deep tanks fitted.



VESSELS AVAILABLE

Newburgh Shipyards, Inc.— No deep tanks fitted.

Name	*D. W T.*	*Gross*	*Net*	*Date built*	*Location*
Irvington	8,822	5,584	3,747	Nov., 1919	Jones Point, N. Y.
***Newburgh**	8,822	5,501	3,390	Dec., 1918	"
Cold Spring	8,822	6,075	3,780	Sept. 1919,	James River, Va.
Firthcliffe	8,822	6,075	3,780	Oct., 1919	"
Monroe	8,822	5,628	3,477	April, 1920	"
***New Windsor**	8,822	5,590	3,541	Mar., 1919	"
Peekskill	8,822	5,283	3,450	Dec, 1919	"
***Poughkeepsie**	8,822	5,388	3,466	April, 1918	"
***Walden**	8,822	5,511	3,780	May, 1919	"
Fishkill	8,822	5,628	3,477	April, 1920	New Orleans, La.

Pensacola Shipbuilding Company — Deep Tanks, Foster Boilers.

City of Sherman	8,705	5,401	3,364	April, 1920	James River, Va.
City of Vernon	8,672	5,401	3,364	June, 1920	"
Cushnoc	8,605	5,405	3,321	Sept., 1919	"
Escambia	8,605	5,444	3,206	Nov., 1919	"
Noccalula	8,605	5,411	3,375	Dec., 1919	"
Red Mountain	8,605	5,395	3,360	Dec., 1919	"
Rockport	8,611	5,401	3,364	Feb., 1920	"
Bayou Chico	8,533	5,401	3,364	Oct., 1920	Operating.
City of Weatherford	8,571	5,401	3,364	Sept., 1920	"
Hastings	8,537	5,401	3,364	Sept., 1920	"

* Babcock & Wilcox Boilers, all other vessels have Foster Boilers.

Designed sea speed, knots	10.5
Length of engine and boiler rooms	51′ 9″
Diameter and length of propeller shaft	14¾ x 17′ 6¼″
Diameter and length of line shaft	6:13¼″ x 23′ 2″
Diameter and length of thrust shaft	None
Total length of shafting	156′ 6¼″
Shaft center above base line at stern	10′ 9″
Shaft center above base line at Eng. Coup'g	9′ 3″
Engine coupling above tank top	5′ 7″
Engine coupling from after bulkhead	3′ 6″ for'd
Max. propeller diam. allowed by stern frame	19′ 9″

Design Number 1025 (Continued)

(Drawings and photograph on preceeding page)

8,800 D. W. T. STEEL CARGO

Hull Particulars

Builders	*Newburgh Shipyards, Inc.*	*Pensacola, S. B. Co.*
Type of construction	Transverse, fabricated.	Transverse, fabricated.
Superstructures	Poop, bridge and forecastle.	Poop, bridge and forecastle.
Number of holds	5.	4 and deep tanks.
Number of decks	2.	2.
Number and size of hatches	4:29′ 3″ x 20′; 1:18′ x 20′	4:29′ 3″ x 20′; 1:18′ x 20′
Type of bulwarks	Solid	Solid
Cargo booms, number and lift	10:5-ton; 1:30-ton	10:5-ton; 1:30-ton
Length overall	417′ 9½″	417′ 9½″
Length B. P.	401′ 0″	401′ 0″
Beam, moulded	54′ 0″	54′ 0″
Depth, moulded	32′ 10″	32′ 10″
Draft, load summer	25′ 2″	25′ 1⅛″
Displacement at load draft	12,305 tons	12,143 tons
Block coefficient	.809	.802
Prismatic coefficient	.822	.815
Bale cubic: holds, T'n decks and hatches	384,545 cubic feet	356,690 cubic feet
Bale cubic: deep tanks	none	25,050 cubic feet
Bale cubic: bridge	39,411 cubic feet	38,740 cubic feet
Total bale capacity	423,956 cubic feet	416,480 cubic feet
Bale cubic, midship tween decks	13,920 cubic feet	13,500 cubic feet
Total grain capacity	476,205 cubic feet	472,800 cubic feet

	Fresh water	*Salt water*	*Fuel oil*	*Fresh water*	*Salt water*	*Fuel oil*
Cubic feet per long ton	*36*	*35*	*40*	*36*	*35*	*40*
Fore peak, tons	...	120	....	...	110	.....
After peak, tons	...	143	....	...	143	.....
Inner bottoms, tons	137	...	1,023	138	....	1,018
Deep tanks (ballast or oil), tons	...	...	.....	...	822	.....
Settling tanks, tons	...	...	59	...	.....	55
Total, tons	137	263	1,082	138	1,075	1,073

Machinery Particulars

Number and type of boilers	3 Babcock & Wilcox	3 Foster, W. T.
Total boiler heating surface	8,700 square feet	8,745 square feet
Working pressure, pounds gauge	200	200
Main engines	Westinghouse cross compound geared turbines	
Designed H.P. and R.P.M.	3,000 S.H.P. at 90	

(*Continued on left hand column*)

Cubic feet per long ton	*Fresh water 36*	*Salt water 35*	*Fuel oil 40*
Fore peak, tons	...	147	..
After peak, tons	175	...	..
Inner bottoms, tons	200	1,076	..
Total, tons	375	1,223	..

Machinery Particulars

Number and type of boilers	3 Babcock & Wilcox W. T.
Total boiler heating surface	8,703 sq. ft.
Working pressure, lbs. gauge	200
Main engines	Westinghouse cross compound geared turbines
Designed H. P. and R. P. M.	2,900 S. H. P. @ 70
Designed sea speed, knots	10.5
Length of engine and boiler rooms	51′ 9″
Diameter and length of propeller shaft	15⅜″ x 20′ 0″
Diameter and length of line shaft	5:14″ x 18′ 6″ — 1:14″ x 18′ 5″ — 1:14″ x 18′ 9″
Diameter and length of thrust shaft	None
Total length of shafting	149′ 8″
Shaft center above base line, at stern	10′ 9″
Shaft center above base line, at eng. coupl'g	8′ 7½″
Engine coupling above tank top	—
Engine coupling from after bulkhead	3′ 6″ for'd
Max. propeller diam. allowed by stern frame	19′ 9″

VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date built*	*Location*
Auburn	8,868	6,025	3,361	Dec., 1918	James River, Va.

Design "Auburn"

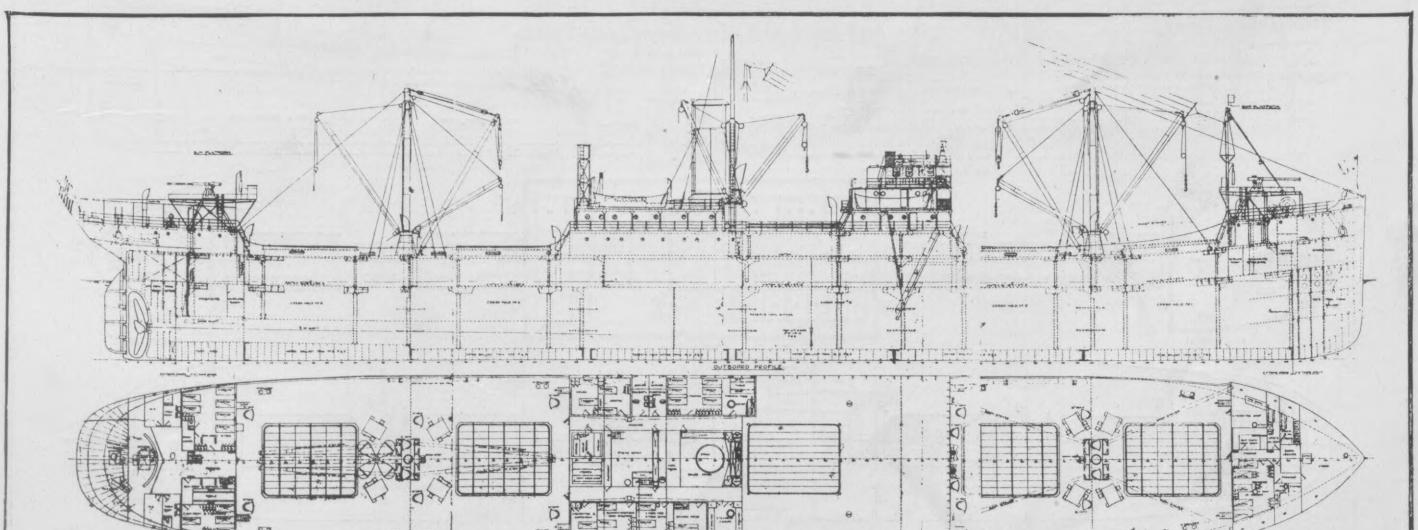
8,800 D. W. T. STEEL CARGO

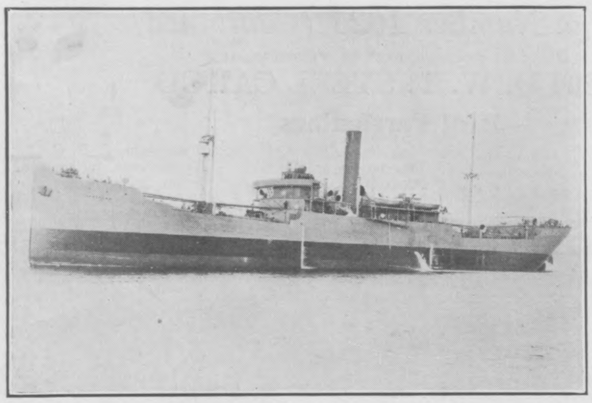
Hull Particulars

Builders	Merchants Shipbuilding Corporation
Type of construction	Transverse framing
Superstructures	Poop, bridge and forecastle
Number of holds	5
Number of decks	2
Number and size of hatches	4: 29′ 3″ x 22′ — 1:27′ x 22′
Type of bulwarks	Solid
Cargo booms, number and lift	10:5-ton: 1:30-ton
Length overall	417′ 5″
Length B. P.	401′ 0″
Beam, moulded	54′ 0″
Depth, moulded	32′ 9″
Draft, load summer	25′ 7″
Displacement at load draft	12,225 tons
Block coefficient	.798
Prismatic coefficient	.812
*Bale cubic, holds, 'tween decks and hatches	397,772 cubic feet
Bale cubic, bridge	27,192 cubic feet
*Total bale capacity	424,964 cubic feet
Bale cubic, midship 'tween decks	7,000 cubic feet
Total grain capacity	462,408 cubic feet

*Including cross bunkers in 'tween deck and hold.

(*Continued on left hand column*)





Design Number 1016

8,800 D. W. T. STEEL CARGO

Hull Particulars

Builders	Baltimore D. D. & S. B. Co.— Groton Iron Works
Type of construction	Longitudinal framing
Superstructures	Poop, bridge and forecastle
Number of holds	4 and deep tanks, where fitted
Number of decks	2
Number and size of hatches	4:17′ x 33′; 1:17′ x 12′
Type of bulwarks	Rail
Cargo booms, number and lift	8:5 ton; 2:3 ton; 1:30 ton
Length overall	423′:9″
Length B. P	410′:5½″
Beam, moulded	54′:0″
Depth, moulded	30′:0″
Draft, load summer	24′:1″
Displacement at load draft	12,260 tons
Block coefficient	.820
Prismatic coefficient	.833

	Baltimore DD. & SB. Co.	*Groton Iron Works*
*Bale capacity, holds, 'tween decks, and hatches, cubic feet	329,933	393,168
Bale capacity, deep tanks, cubic feet	49,387	None
Bale capacity, bridge, cubic feet	33,510	33,510
Total bale capacity, cubic ft.	412,830	426,678
Total grain capacity, cubic ft.	431,258	445,763

* Exclusive of midship 'tween decks.

Cubic feet per long ton	*Fresh water 36*	*Salt water 35*	*Fuel oil 40*	*Fresh water 36*	*Salt water 35*	*Fuel oil 40*
Fore peak, tons	...	199	...	...	149	...
After peak, tons	...	45	...	...	48	...
Inner bottoms, tons	157	...	898	166	...	934
Deep tanks, tons (ballast or oil)	...	1,501	...	...	...	...
Settling tanks, tons	...	...	74	...	...	76
Total	157	1,745	972	166	197	1,010

VESSELS AVAILABLE

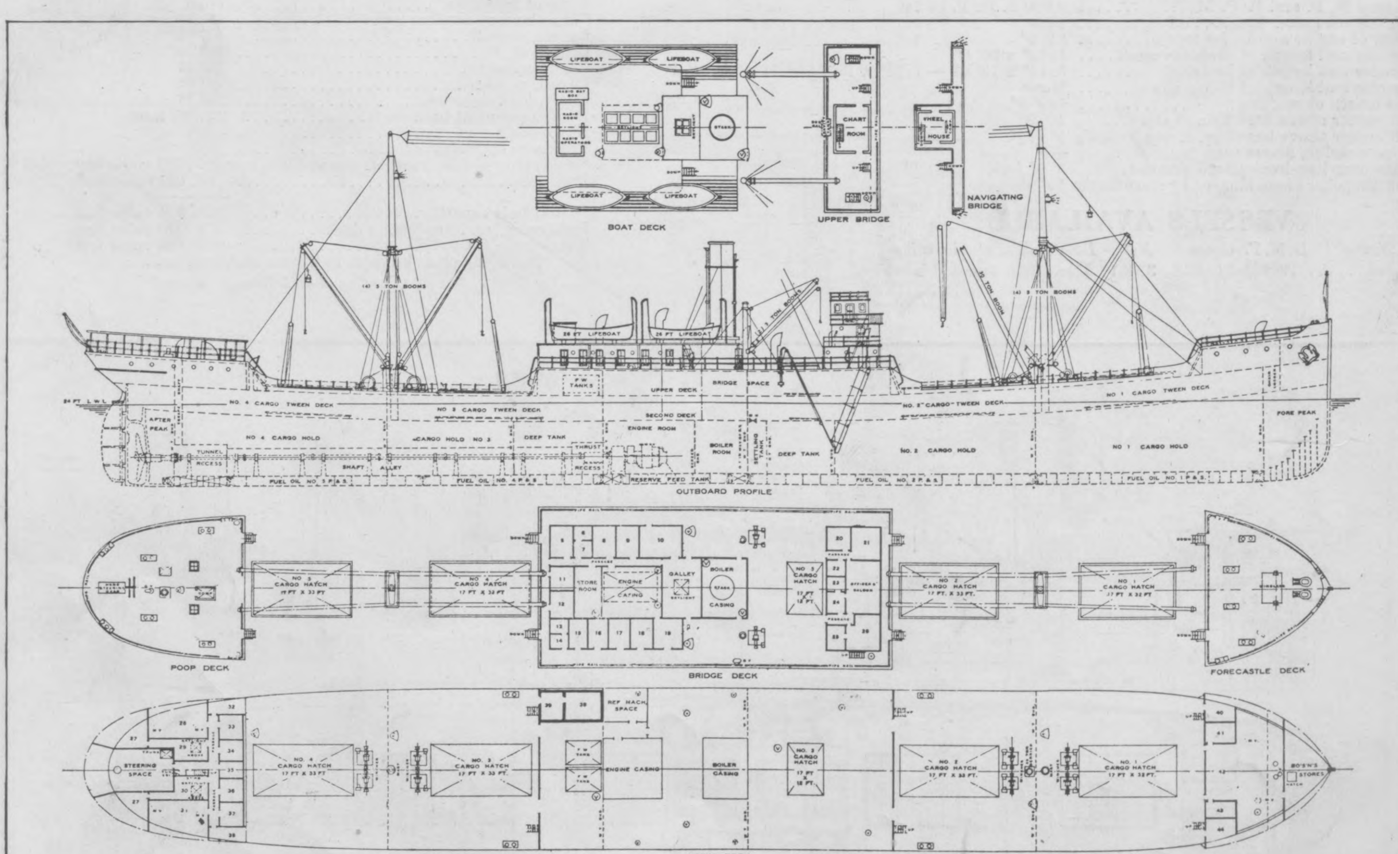
Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
BALTIMORE D. D. & S. B. CO. (Deep Tanks)					
***Benoni**	8,785	6,330	3,959	July, 1919	Jones Point, N. Y.
Yesoking	8,790	5,749	3,556	May, 1919	"
Oscoda	8,786	5,780	3,540	Mar., 1919	Arlington, S. I.
Galahad	8,790	5,728	3,547	Apr., 1919	Hog Island, Pa.
Naiwa	8,858	6,240	4,704	Oct., 1918	"
***Dauperata**	8,785	5,720	3,545	Sept., 1919	James River, Va.
Osawatomie	8,789	5,720	3,559	Feb., 1919	"
Fort Wayne	8,786	6,231	3,921	Dec., 1918	San Francisco, Calif.

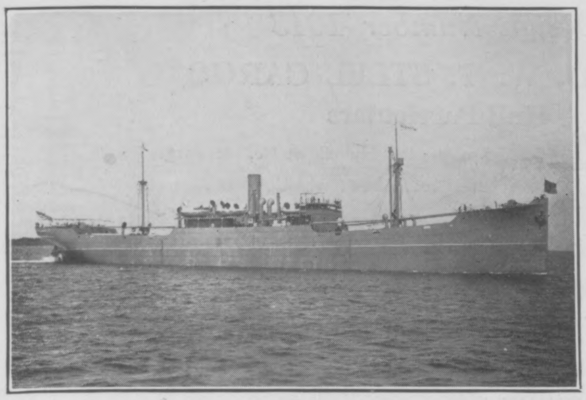
Note: Vessels marked thus * have a 2,500 S.H.P. DeLaval geared turbine.

GROTON IRON WORKS (No Deep Tanks)					
Merry Mount	8,626	5,724	3,476	Oct., 1919	Jones Point, N. Y.
Nameaug	8,626	6,338	3,894	Aug., 1919	"
Quinnipiac	8,591	6,202	3,844	Dec., 1919	"
Hartford	8,591	5,703	3,504	Dec., 1919	James River, Va.
Tollard	8,764	5,874	3,609	Apr., 1919	"
Worcester	8,626	5,918	3,536	June, 1919	"

Machinery Particulars

Number and type of boilers	4 Heine, W. T.
Total boiler heating surface	11,132 square feet
Working pressure, lbs. gauge	200
Main engine	Geared turbine — General Electric Co., except as noted
Designed H. P. and R. P. M.	2,500 S. H. P. at 90
Designed sea speed, knots	10.5
Length of engine and boiler rooms	49′:6″
Diameter and length of propeller shaft	14:⅛″ x 16′:10″
Diameter and length of line shaft	6:12½″ x 23′:0″
Diameter and length of thrust shaft	13¼″ x 7′:0″
Total length of shafting	161′:0″
Shaft center above base line at stern	9′:6″
Shaft center above base line, eng. coup'lg.	9′:6″
Engine coupling above tank top	5′:10″
Engine coupling from after bulkhead	2′:11½″ for'd
Maximum propeller diameter allowed by stern frame	17′:3″





Design Number 1019

8,800 D. W. T. STEEL CARGO

Hull Particulars

Builders	Atlantic Corporation — Western Pipe & Steel Co.
Type of construction	Transverse framing
Superstructures	Poop, bridge and forecastle
Number of holds	4 and deep tanks, where fitted
Number of decks	2
Number and size of hatches	4:31′ 6″ x 21′ 0″; 1:15′ 9″ x 17′ 0″
Type of bulwarks	Solid
Cargo booms, number and lift	8: 5 ton; 2: 3 ton; 1: 30 ton
Length over all	427′; 0″
Length B. P	410′; 5½″
Beam, moulded	54′; 0″
Depth, moulded	29′; 9″
Draft, load summer	24′; 2″
Displacement at load draft	12,220
Block coefficient	.817
Prismatic coefficient	.827

	Atlantic Corp.		*Western Pipe & Stee*	
Bale cubic, holds, 'tween decks and hatches, cu. ft.	370,092	349,321	374,423	354,840
Bale cubic, deep tanks, cu. ft	None	21,272	None	18,064
Bale cubic, bridge, cu. ft	39,733*	42,204*	37,166	37,823
Bale cubic, midship 'tween decks, cu. ft	13,200	13,200	14,635	14,635
Bale capacity, total	423,025	425,997	426,224	425,362
Grain capacity, total	444,144	447,247	475,096	475,096

* Including forecastle cargo space.

	Atlantic Corporation						*Western Pipe & Steel Co.*					
	F. W. 36	*S. W. 35*	*F. O. 40*	*F. W. 36*	*S. W. 35*	*F. O. 40*	*F. W. 36*	*S. W. 35*	*F. O. 40*	*F. W. 36*	*S. W. 35*	*F. O. 40*
Fore peak, tons	...	87	....	...	87	....	...	124	....	...	124	....
After peak, tons	...	250	....	...	250	....	...	274	....	...	274	....
Inner bottoms, tons	188	....	955	175	....	950	197	....	945	197	....	945
*Deep tanks, tons	...	....	....	...	714	....	...	....	....	...	608	....
Settling tanks, tons	...	....	80	...	....	74	...	....	82	...	....	82
Total, tons	188	337	1035	175	1051	1024	197	398	1027	197	1006	1027

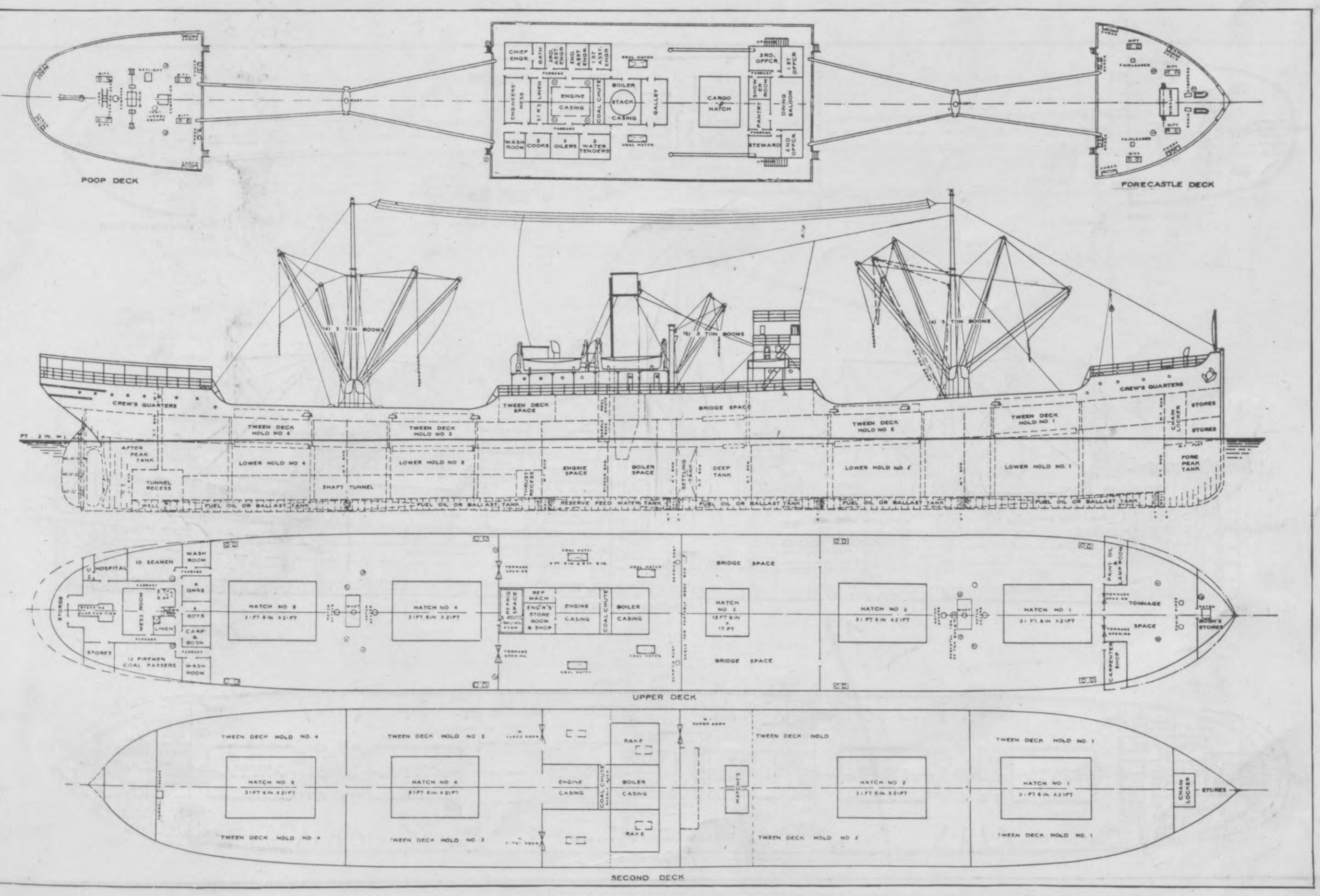
* Oil or coal.

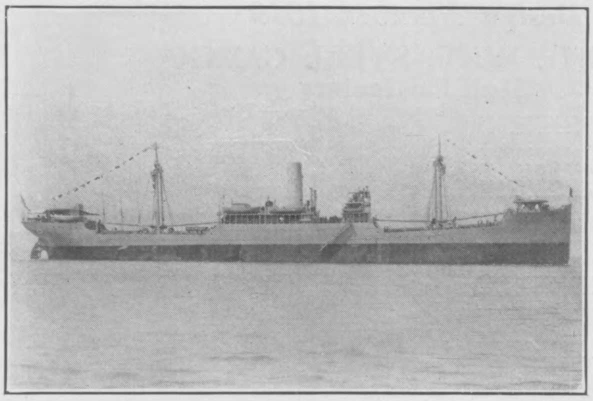
Machinery Particulars

	Atlantic Corporation	*Western Pipe & Steel Co.*
Number and type of boiler	3 Foster W. T.	4 Heine, W. T.
Total boiler heating surface	9150 sq. ft.	11,132 sq. ft.
Working pressure, lbs. gauge	200	200
Main engine	24½″–41½″–72″ x 48″ Mason Machine Works	Geared turbine, General Electric Co.
Designed H. P. and R. P. M.	2500 I. H. P. at 78	2500 S. H. P. at 90
Designed sea speed, knots	10.5	10.5
Diameter and length of propeller shaft	15¼ x 17′ 7″	13½″ x 16′ 9⅝″
Diameter and length of line shaft	6:13⅜″ x 21′ 10½″	6:12½″ x 22′ 6″
Diameter and length of thrust shaft	14″ x 12′ 9⅜″	13″ x 9′ 3″
Total length of shafting	161′ 7⅜″	161′ 0⅝″
Length of engine and boiler rooms	49′ 6″	49′ 6″
Shaft center above base line at stern	9″ 9″	9′ 9″
Shaft center above base line at engine coupling	7′ 7½″	9′ 9″
Engine coupling above tank top	3′ 11½″	6′ 1″
Engine coupling from after bulkhead	16⅜″ for'd	20½″ for'd
Maximum propeller diameter allowed by stern frame	17′ 6″	17′9″

VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
ATLANTIC CORPORATION — Vessels marked thus * are Oil burners fitted with Deep Tanks.					
***Brookline**	8,550	5,527	3,965	May, 1920	Arlington, S. I.
Norumbega	8,630	5,582	4,091	Feb., 1920	"
Portsmouth	8,630	5,881	4,544	Oct., 1919	Hog Island, Pa.
Babboosic	8,630	5,970	4,465	Sept., 1919	James River, Va.
Kisnop	8,630	5,874	4,536	Aug., 1919	"
Nipmuc	8,630	5,969	4,477	Dec., 1919	"
***Pagasset**	8,550	5,527	3,965	Oct., 1920	"
***Tolosa**	8,550	5,527	3,965	Aug. 1920	"
***Pachet**	8,550	5,527	3,965	Sept., 1920	(Spot) Baltimore
***Springfield**	8,550	5,641	3,504	June, 1920	Operating
WESTERN PIPE & STEEL — Vessels marked thus * are fitted with deep tanks.					
Isanti	8,726	5,713	4,129	Nov., 1918	Hog Island, Pa.
Nantahala	8,726	5,714	4,045	Sept., 1918	Jones Point, N.Y.
West Avenal	8,735	5,692	4,020	Jan., 1919	Arlington, S. I.
***West Vaca**	8,660	5,548	4,151	May, 1919	"
Oskaloosa	8,750	5,623	4,189	Oct., 1918	James River, Va.
***West Ashawa**	8,660	5,609	4,095	May, 1919	"
***West Alcoz**	8,660	5,606	4,230	June, 1919	"





Design Number 1013

8,400 D. W. T. STEEL CARGO

Hull Particulars

Builder	Los Angeles Shipbuilding Co. (Contract No. 4)
Type of construction	Transverse framing
Superstructures	Poop, bridge and forecastle
Number of holds	3
Number of decks	2
Number and size of hatches	1:31′ 6″ x 17′ 2″; 2:29′ 3″ x 17′ 2″ 1:27′ 0″ x 17′ 2″; 1:17′ 2″ x 15′ 9″
Type of bulwarks	Rail
Cargo booms, number and lift	8:5 ton; 2:3 ton; 1:30 ton
Length overall	423′ 9″
Length B. P.	410′ 5½″
Beam, moulded	54′ 0″
Depth, moulded	29′ 9″
Draft, load summer	23′ 11¼″
Displacement at load draft	12,086 tons
Block coefficient	.806
Prismatic coefficient	.818
Bale capacity, holds and 'tween decks	375,300 cubic feet (exclusive of hatches and midship 'tween decks)
Bale capacity, bridge	34,700 cubic feet
Total bale capacity	410,000 cubic feet
Total grain capacity	461,178 cubic feet

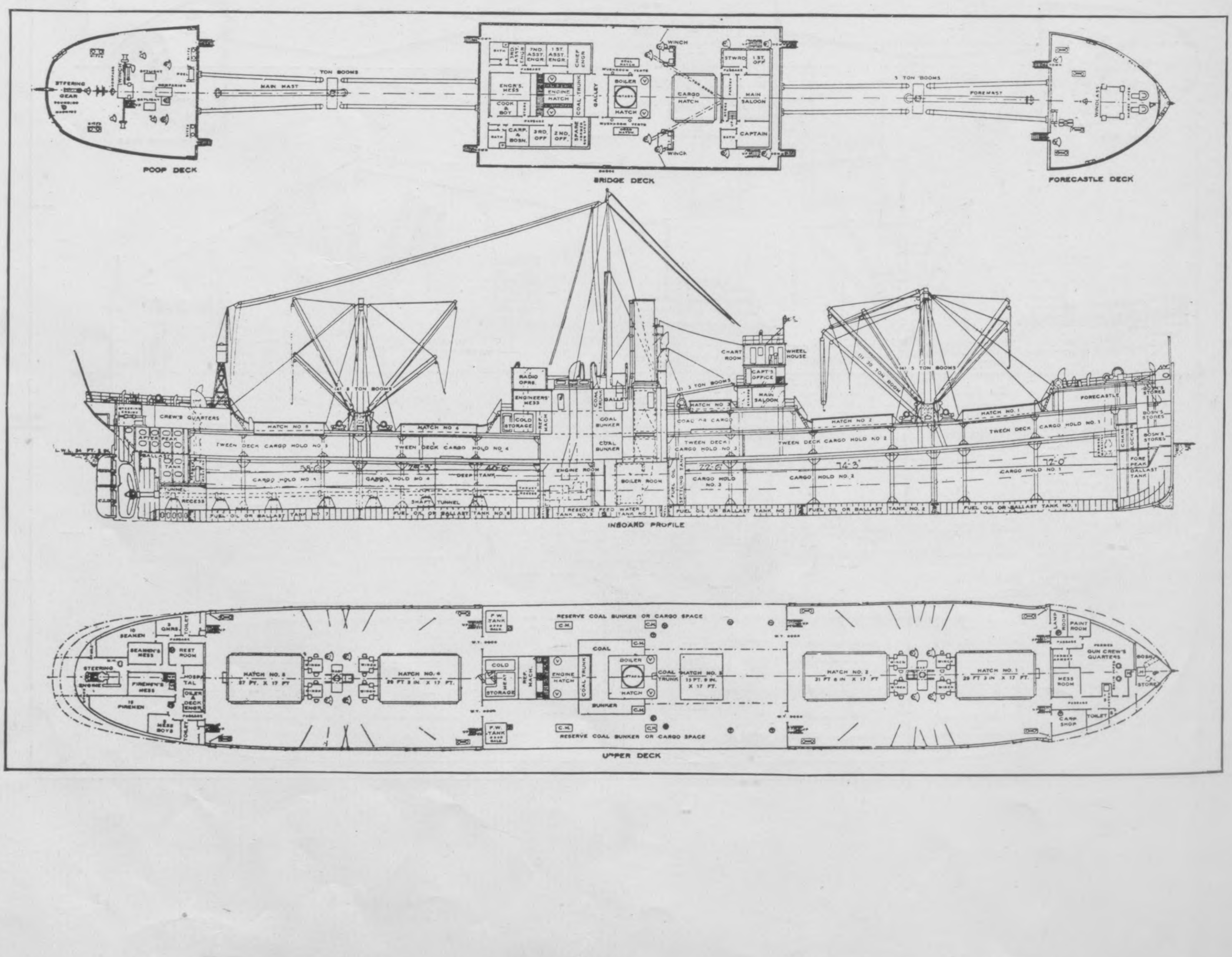
Cubic feet per long ton	Fresh water *36*	Salt water *35*	Fuel oil *40*
Fore peak, tons	...	109	...
After peak, tons	...	242	...
Inner bottoms, tons	198	...	907
Settling tanks, tons	...	...	71
Total tons	198	351	978

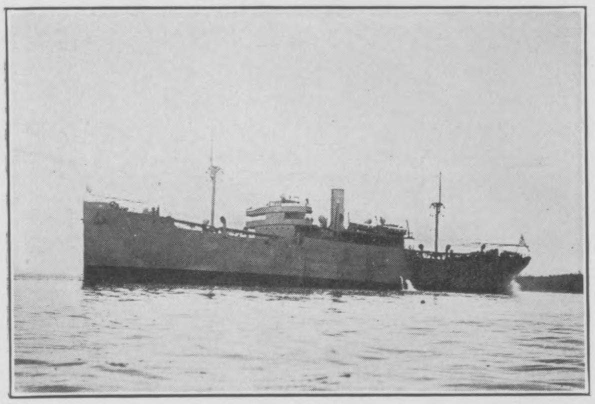
VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
Accomac	8,341	5,274	3,213	June, 1918	Jones Point, N. Y.
Wakulla	8,435	5,435	3,323	July, 1918	"
Wampum	8,430	5,451	3,334	July, 1918	"
West Galoc	8,503	5,392	3,293	Aug., 1918	"
Wassaic	8,474	5,529	3,387	July, 1918	Tottenville, S. I.
West Galeta	8,476	5,435	3,323	Sept., 1918	James River, Va.
West Zucker	8,432	5,548	3,400	Nov., 1918	"
West Zula	8,388	6,000	4,552	Sept., 1918	"

Machinery Particulars

Number and type of boilers	4 Heine, W. T.
Total boiler heating surface	11,600 sq. ft.
Working pressure, lbs. gauge	200
Main engine	Geared turbines — Westinghouse cross compound
Designed H. P. and R. P. M.	3,000 S. H. P. at 100
Designed sea speed, knots	11
Length of engine and boiler rooms	49′ 6″
Diameter and length of propeller shaft	14½″ x 17′ 2½″
Diameter and length of line shaft	7′ 13¼″ x 20′ 0″
Diameter and length of thrust shaft	None
Total length of shafting	157′ 2½″
Shaft center above base line, at stern	9′ 6″
Shaft center above base line, Eng. coupl'g.	9′ 6″
Engine coupling above tank top	5′ 10″
Engine coupling from after bulkhead	36″ aft
Maximum propeller diam. allowed by stern frame	17′ 2″





Design Number 1014

7,500 D. W. T. STEEL CARGO

Hull Particulars

Builder	Todd Drydock and Construction Company
Type of construction	Longitudinal
Superstructures	Poop, bridge and forecastle
Number of holds	4 and deep tanks
Number of decks	2
Number and size of hatches	4:21′ x 32′ 6″; 1:13′ x 17′
Type of bulwarks	Solid
Cargo booms, number and lift	8 5 ton; 2 3 ton
Length overall	396′ 0″
Length B. P.	380′ 6″
Beam, moulded	53′ 0″
Depth, mould d.	29′ 3″
Draft load summer	23′ 8″
Displacement at load draft	10,732 tons
Block coefficient	.796
Prismatic coefficient	.806
Bale capacity, holds, 'tween decks and hatches	308,088 cubic feet (including 12,030 cu. ft. midship 'tween decks)
Bale capacity, deep tanks	31,103 cubic feet
Bale capacity, bridge and poop	32,445 cubic feet
Total bale capacity	371,636 cubic feet
Total grain capacity	405,771 cubic feet

	Fresh water	Salt water	Fuel oil
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	...	91	...
After peak, tons	...	127	...
Inner bottoms, tons	203	191	776
Deep tanks, tons (cargo, ballast or oil)	...	993	...
Settling tanks, tons (at sides)	...	...	153
Total tons	203	1,402	929

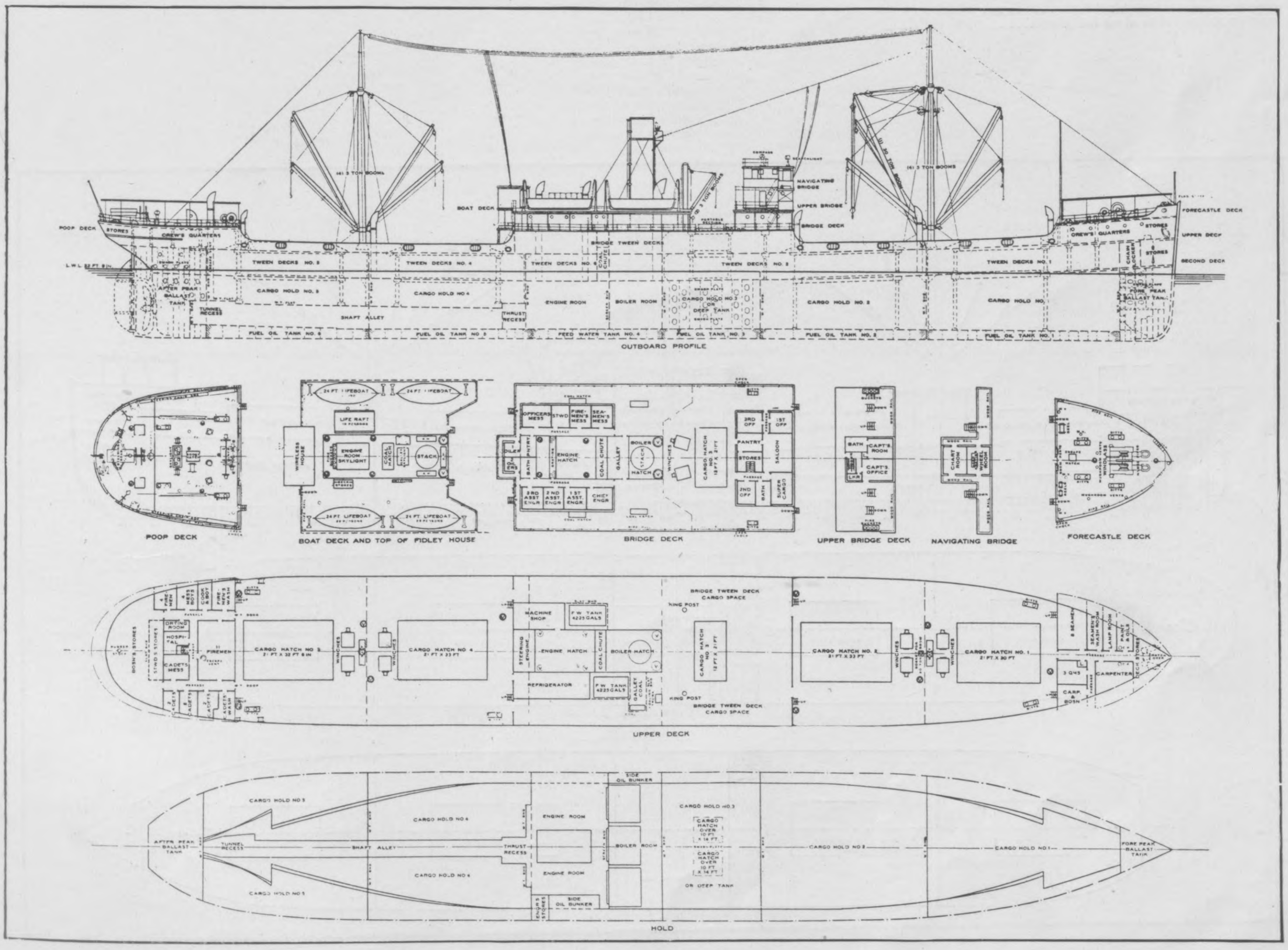
VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
***Quitticas**	7,690	4,767	2,950	June, 1919	Arlington, S. I.
Deranof	7,630	5,227	3,827	Dec., 1918	Hog Island, Pa
***Remus**	7,644	4,744	2,931	May, 1919	James River, Va.
Williamantic	7,615	4,857	2,992	Nov., 1918	"
Delight	7,650	5,141	3,895	Sept., 1919	Seattle, Wash.
***Jacona**	7,668	4,803	3,006	Apr., 1919	New Orleans, La.
Ossining	7,658	4,801	2,968	June, 1919	Operating

*Spot Ship.

Machinery Particulars

Number and type of boilers	3 Badenhausen, W. T.
Total boiler heating surface	9,006 sq. ft.
Working pressure, lbs. gauge	190
Main engine	24″ 40″ 70″ x 48″ — Skinner & Eddy
Designed H. P. and R. P. M.	2,300 I. H. P. at 73
Designed sea speed, knots	10½
Length of engine and boiler rooms	50′ 0″
Diameter and length of propeller shaft	14 9-32″ x 20′ 9¼″
Diameter and length of line shaft	6:12 11-16″ x 19′ 1″
Diameter and length of thrust shaft	13⅜″ x 19′ 4″
Total length of shafting	145′ 7¾″
Shaft center above base line, at stern	10′ 2⅞″
Shaft center above base line, Eng. coupl'g.	7′ 6″
Engine coupling above tank top	4′ 0″
Engine coupling from after bulkhead	3′ 7″ for'd
Maximum propeller diam. allowed by stern frame	18′ 3″



Design "Mount Shasta"

7,200 D. W. T. STEEL CARGO

Hull Particulars

Builder	Moore Snipbuilding Company
Type of construction	Transverse framing
Superstructures	Poop, bridge and forecastle
Number of holds	4 and deep tanks
Number of decks	2
Number and size of hatches	4:29′ 9″ x 18′; 1: 8′ x 16′
Type of Bulwarks	Rail
Cargo booms, number and lift	10 3-ton; 1 30-ton
Length overall	390′ 0″
Length B. P.	376′ 0″
Beam, moulded	52′ 3″
Depth, moulded	28′ 0″
Draft, load summer	22′ 11″
Displacement at load draft	10,170 tons
Block coefficient	.791
Bale cubic, holds, 'tween decks and hatches	301,120 cubic feet
Bale cubic, deep tanks	17,182 cubic feet
Bale cubic, bridge	14,894 cubic feet
Total bale capacity	333,196 cubic feet
Total grain capacity	360,873 cubic feet

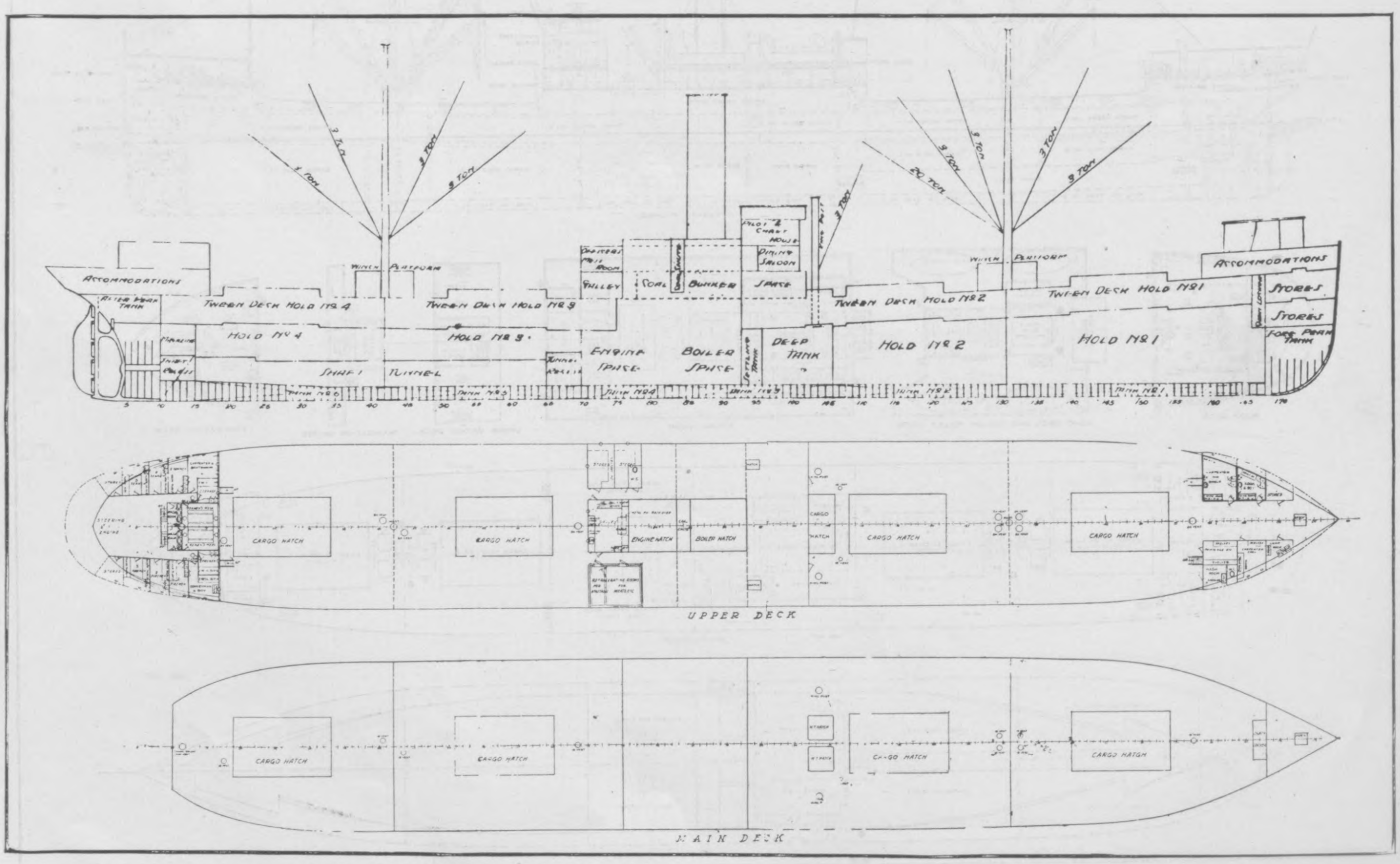
	Fresh water	Salt water	Fuel oil
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	..	96	...
After peak, tons	..	134	...
Inner bottom, tons	95	...	855
Deep tanks, tons	..	523	...
Settling tanks, tons	..	...	85
Total, tons	95	753	940

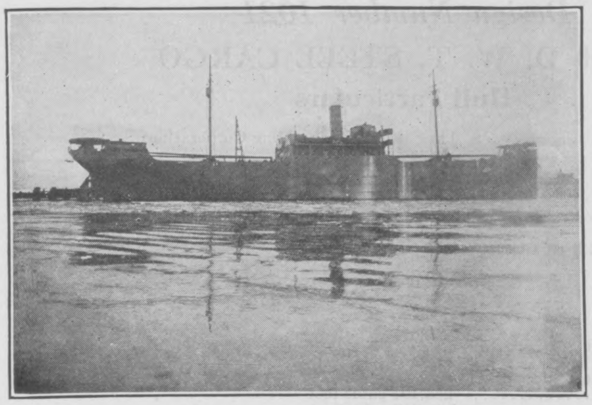
VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date built*	*Location*
Mount Shasta.	7,242	4,729	2,919	Dec., 1917	James River, Va.

Machinery Particulars

Number and type of boilers	2 Babcox & Wilcox W. T.
Total boiler heating surface	5418 sq. ft.
Working pressure, lbs. gauge	225
Main engines	General Electric Company Geared turbine
Designed H. P. and R. P. M.	2,500 S. H. P. @ 90
Designed sea speed, knots	11
Length of engine and boiler rooms	48′ 9″
Diameter and length of propeller shaft	14″ x 19′ 1″
Diameter and length of line shaft	6:13″ x 19′ 1½″
Diameter and length of thrust shaft	13″ x 10′ 9″
Total length of shafting	144′ 6¼″
Shaft center above base line at stern	9′ 2″
Shaft center above base line at eng. coupl'g	9′ 2″
Engine coupling above tank top	5′ 8″
Engine coupling from after bulkhead	24″ for'd





Design Number 1152

6,300 D. W. T. STEEL CARGO

Hull Particulars

Builder	Baltimore Dry Dock & Shipbuilding Co
Type of construction	Longitudinal framing
Superstructures	Poop, bridge & forecastle
Number of holds	4
Number of decks	2
Number and size of hatches	1:30′ x 20′; 1:21′x 20′; 2:24′x 18′
Type of bulwarks	Rail
Cargo booms, number and lift	85 ton
Length overall	353′ 3″
Length B. P	340′ 0″
Beam, moulded	49′ 0″
Depth, moulded	28′ 7 3/14″
Draft, load summer	23′ 1½″
Displacement at load draft	8,830 tons
Block coefficient	.821
Prismatic coefficient	.828
Bale capacity, hold and 'tween decks	256,120 cubic feet
Gross bunker, number 2 hold (Coal)	17,670 cubic feet
Upper and lower tween decks (Coal)	17,890 cubic feet
Bridge (Coal)	16,770 cubic feet
Total (exclusive of side bunkers and saddle backs)	308,450 cubic feet
Grain capacity	317,820 cubic feet

	Fresh water	Salt water	Fuel oil
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	...	98	...
After peak, tons	...	128	...
Inner bottoms, tons			
Total, tons	120	897	...

VESSELS AVAILABLE

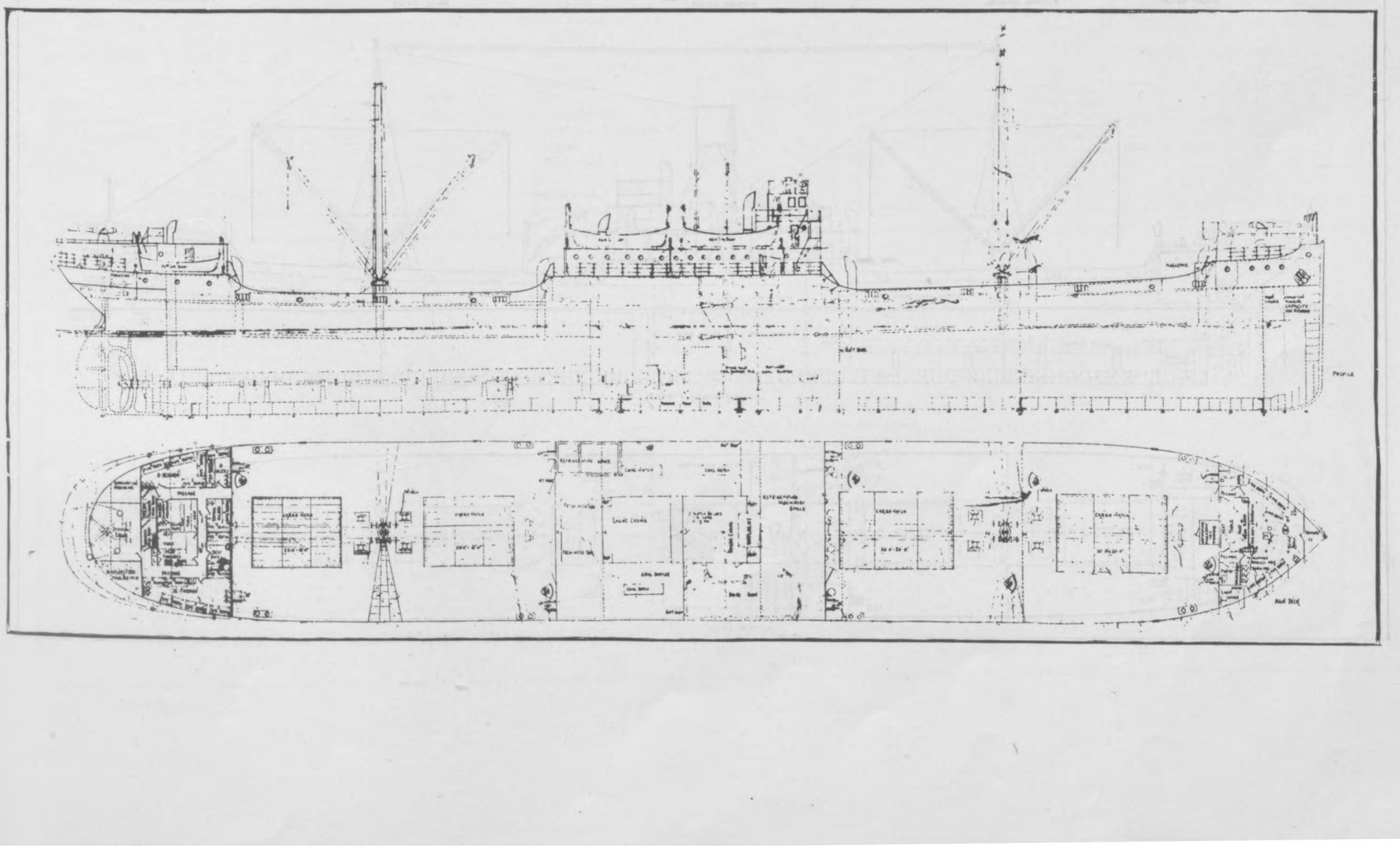
Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
Polar Bear	6,296	4,297	2,623	Dec., 1918	Jones Point, N. Y.
Polar Star	6,300	3,297	2,623	Dec., 1918	"
Laurel	6,300	4,296	2,639	Mar., 1919	"
***Elinor**	6,317	4,280	2,618	Mar., 1918	Arlington, S. I.
Calvert	6,315	4,071	2,514	May, 1919	James River, Va.

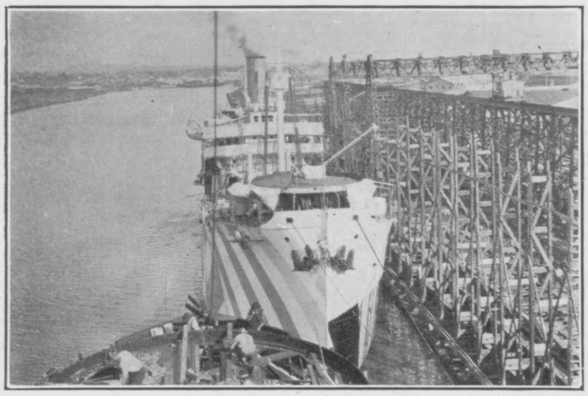
* General Electric Turbines and Gears.

NOTE;—All vessels are coal burners and have a non-W. T. center keelson.

Machinery Particulars

Number and type of boilers	3 Scotch
Total boiler heating surface	5,100 square feet
Working pressure, lbs. gauge	195
Main engine	Geared turbine — Westinghous
Designed H. P. and R. P. M	1,800 S. H. P. at 90
Designed sea speed, knots	11
Length of engine and boiler rooms	44′ 0″
Diameter and length of propeller shaft	12½″ x 15′ 1″
Diameter and length of line shaft	5:11⅛″ x 22′ 6″
Diameter and length of thrust shaft	11⅝″ x 6′ 11″
Total length of shafting	134′ 6″
Shaft center above B. L. at stern	8′6″
Shaft center above B. L., Eng. coupl'g	8′6″
Engine coupling above tank top	5′1½″
Engine coupling from after bulkhead	12″ for'd
Maximum propeller diameter allowed by stern frame	15′3″





Design Number 1021

6,000 D. W. T. STEEL CARGO

Hull Particulars

Builder	Long Beach Shipbuilding Corporation
Type of construction	Transverse framing
Superstructures	Poop, bridge, forecastle
Number of holds	4
Number of decks	2
Number and size of hatches	4: 17′ x 25′; 1: 17′ x 12′ 6″
Type of bulwarks	Solid
Cargo booms, number and lift	11:5 ton
Length overall	354′ 3″
Length B. P.	341′ 0″
Beam, moulded	48′ 0″
Depth, moulded	27′ 3″
Draft, load summer	22′ 4″
Displacement at load draft	8,475 tons
Block coefficient	.812
Bale capacity, holds, 'tween decks and hatches	253,404 cubic feet
Bale capacity, bridge	9,240 cubic feet
Total bale capacity	262,644
Total grain capacity	293,130

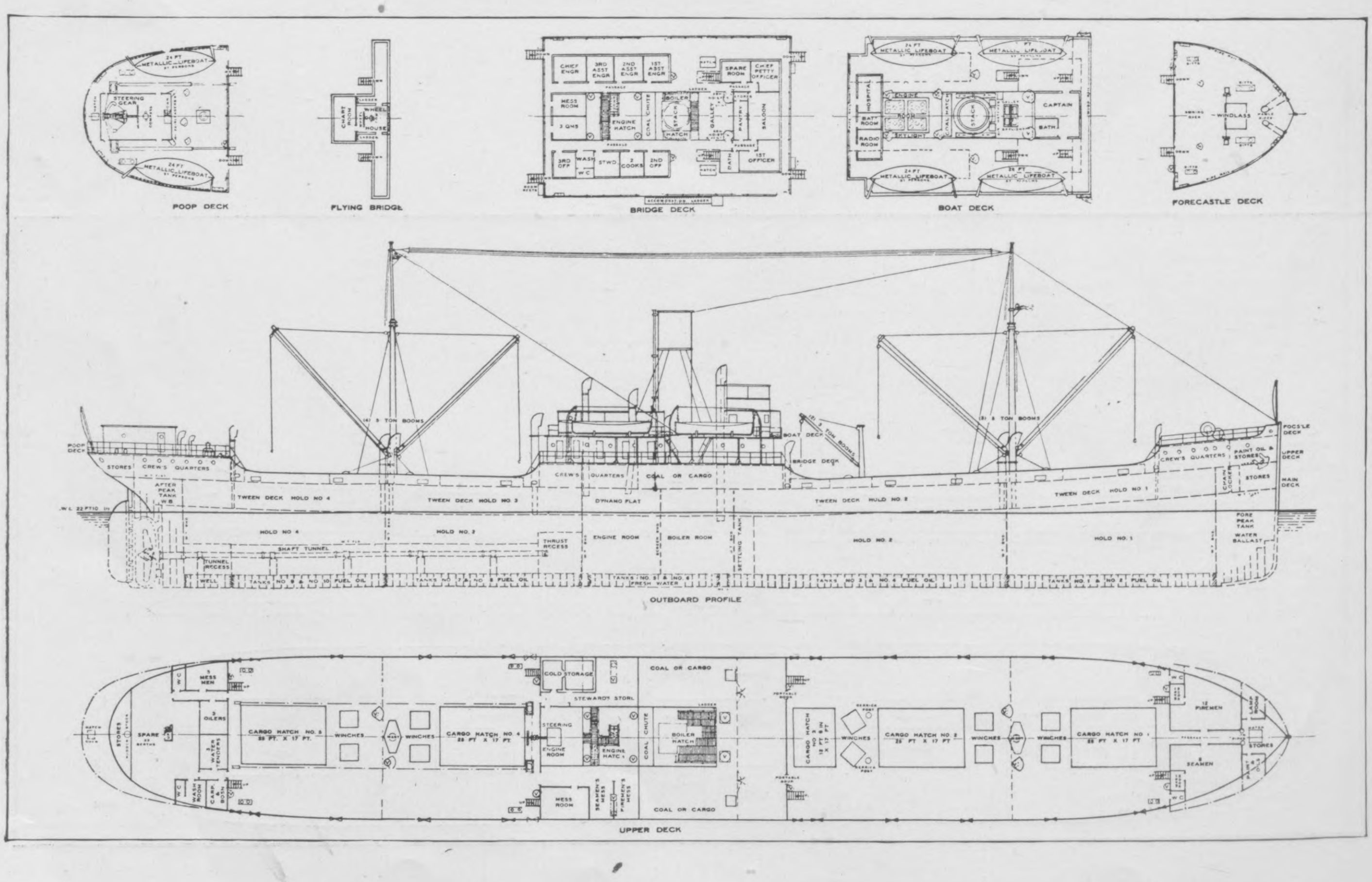
Cubic feet per long ton	Fresh water 36	Salt water 35	Fuel oil 40
Fore peak, tons	...	120	...
After peak, tons	...	102	...
Inner bottoms, tons	137	...	652
Settling tanks, tons	...	...	61
Total, tons	137	222	713

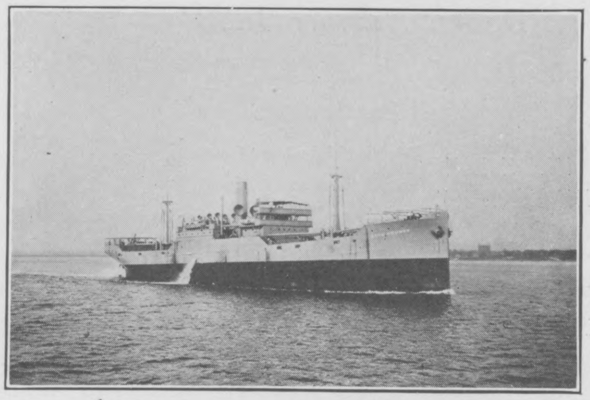
Machinery Particulars

Number and type of boiler	3 Heine, W. T.
Total boile· heating surface	8,700 square feet
Working pressure, lb. gauge	200
Main engine	Geared turbine — General Electric Co.
Designed H. P. and R. P. M.	2,500 S. H. P. at 90
Designed sea peed, knots	11
Length of engine and boiler room	45′ 10″
Diameter and length of propeller shaft	14″ x 13′ 8½″
Diameter and length of line shaft	5 12½″ x 21′ 3⅜″
Diameter and length of thrust shaft	13¼″ x 10′ 9½″
Total length of shafting	130′ 10⅞″
Shaft center above base line, at stern	9′ 8″
Shaft center above base line, Eng. Coupl'g.	9′ 8″
Engine coupling above tank top	6′ 3″
Engine coupling from after bulkhead	6½″ aft.
Maximum propeller diameter allowed by stern frame	17′ 9″

VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
Oshkosh	5,940	3,961	2,393	Nov., 1918	Jones Point, N. Y
Ozaukee	5,940	4,045	2,835	Sept., 1918	"





Design Number 1023

5,350 D. W. T. STEEL CARGO

Hull Particulars

Builder	Submarine Boat Corporation
Type of construction	Transverse
Superstructures	Poop, bridge, forecastle
Number of holds	4 and deep tanks
Number of decks	1 (tween deck in number 1 and number 4 holds)
Number and size of hatches	2:18′ x 29′ 3″; 2:18′ x 24′ 9″; 1:9′ x 16′
Type of bulwarks	Solid
Cargo booms, number and lift	8:5 ton; 2:1½ ton
Length overall	335′ 6″
Length B. P.	324′ 0″
Beam, moulded	46′ 0″
Depth, moulded	28′ 6″
Draft, load summer	22′ 11″
Displacement at load draft	7,535 tons
Block coefficient	.789
Prismatic coefficient	.793
Bale capacity, holds, tween decks and hatches	189,750 cubic feet
Bale capacity, deep tanks	11,300 cubic feet
Bale capacity, bridge	25,100 cubic feet
Bale capacity, total	226,150 cubic feet
Grain capacity, total	269,600 cubic feet

Machinery Particulars

Number and type of boilers	2 Babcock & Wilcox, W. T.
Total boiler heating surface	5,800 square feet.
Working pressure, pounds gauge	200
Main engine	Geared Turbine, Westinghouse
Designed H. P. and R. P. M.	1,500 S. H. P. at 90
Designed sea speed, knots	10½
Length of engine and boiler rooms	47′ 3″
Diameter and length of propeller shaft	11 $\frac{25}{32}$″ x 18′ 9½″
Diameter and length of line shaft	5:10 $\frac{9}{16}$ x 20′ 7″
Diameter and length of thrust shaft	None
Total length of shafting	122′ 8½″
Shaft center above base line at stern	8′ 10″
Shaft center above base line at engine coupling	9′ 8″
Engine coupling above tank top	6′ 3″
Engine coupling from after bulkhead	3″ for'd
Maximum propeller diameter allowed by stern frame	15′ 9″

	Fresh water	*Salt water*	*Fuel o*
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	...	111	...
After peak, tons	...	70	...
Inner bottoms, tons	154	...	603
Deep tanks, tons (cargo, ballast or oil)	...	394	...
Settling tanks, tons	...	...	27
Total, tons	154	575	630

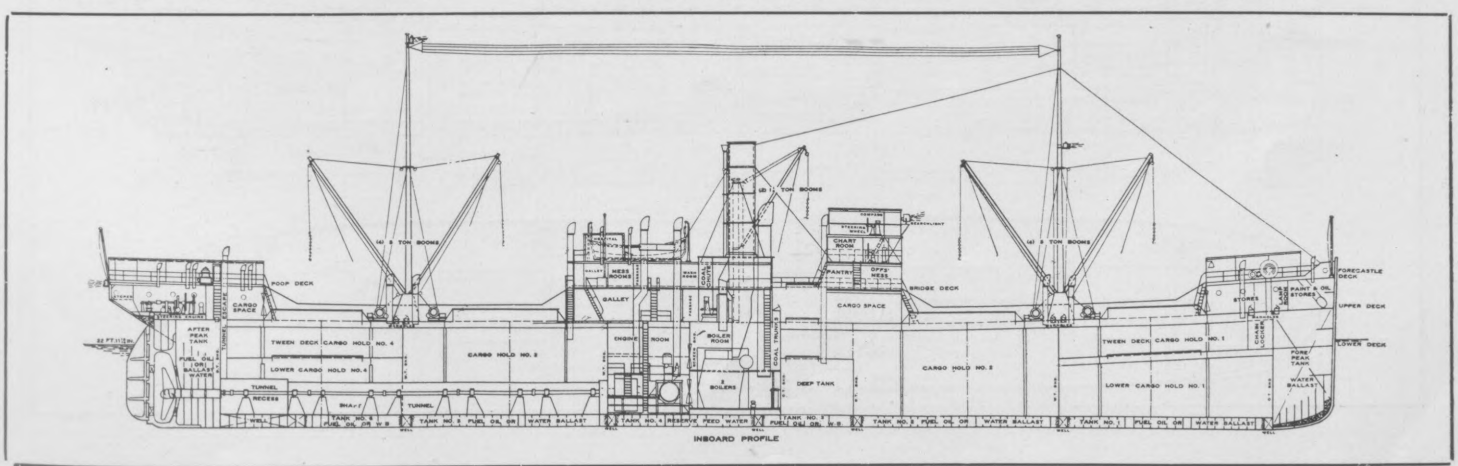
VESSELS AVAILABLE

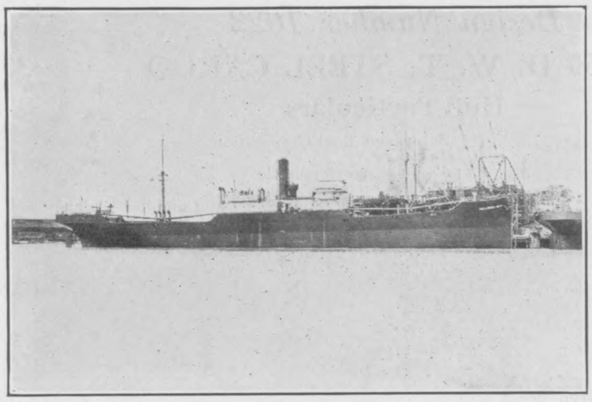
Name	*D.W.T.*	*Gross*	*Net*	*Date Built*
Located at Jones Point, N. Y.				
Ablanset	5,227	3,545	2,174	Sept., 1919
Alamosa	5,095	3,545	2,179	Mar., 1919
Asabeth	5,295	3,545	2,174	Sept., 1919
***Buffalo Brdg**	5,291	3,315	2,017	Oct., 1919
***Chetopa**	5,207	3,545	2,179	Aug., 1919
Chicago Bridge	5,182	3,289	2,004	April, 1919
***Cokato**	5,135	3,545	2,179	Feb., 1919
Delavan	5,288	3,283	1,996	Sept., 1919
Faraby	5,187	3,283	2,002	May, 1919
***Fort Armstrong**	5,255	3,545	2,174	May, 1920
Fort Pitt Brdg	5,105	3,283	2,001	April, 1919
***Haddon**	5,258	3,545	2,174	Sept., 1919
Independent Bridge	5,293	3,545	2,174	Oct., 1919
Indiana Bridge	5,295	3,545	2,612	Dec., 1919
Jackson	5,196	3,283	2,001	June, 1919
Massic	5,340	3,545	2,174	Jan., 1920
Moosehausic	5,290	3,283	1,996	Oct., 1919
***Nonantum**	5,293	3,545	2,174	Sept., 1919
Onekama	5,220	3,545	2,179	Aug., 1919
Oronoke	5,340	3,545	2,174	June, 1920
***Plow City**	5,340	3,283	1,996	April, 1920
***Pontia**	5,274	3,283	1,996	Aug., 1919
***Suwied**	5,340	3,545	2,174	Mar., 1920
***Tashmoo**	5,340	3,283	1,996	Mar., 1920
Toledo Bridge	5,340	3,545	2,174	Jan., 1920
Vincennes Brdg.	5,340	3,283	2,000	Jan., 1920
Located at Arlington, S. I.				
Kootenai	5,295	3,283	2,001	Nov., 1919
***Marsodak**	5,286	3,545	2,174	Oct., 1919
***Milwaukee Bridge**	5,191	3,275	1,996	May, 1919
***Monana**	5,223	3,545	2,174	Aug., 1919
Opequan	5,204	3,545	2,174	June, 1919
Wheeling Mold	5,340	3,283	1,995	June, 1919
Located at Hog Island, Pa.				
Bayhead	5,200	3,257	1,978	July, 1919
Charlot	5,150	3,286	2,003	Apr., 1919
Davidson County	5,204	3,283	1,996	July, 1919
Lackawanna Valley	5,255	3,299	2,007	Sept., 1919
Margus	5,300	3,545	2,174	Dec., 1919
Monomac	5,340	3,283	1,996	Jan., 1920
***Moravia Bridge**	5,340	3,283	1,996	Mar., 1920
Opelika	5,125	3,283	2,000	May, 1919
Panola	5,125	3,545	2,179	May, 1919
Parksville	5,290	3,545	2,174	Sept., 1919
***Pittsburgh Bridge**	5,340	3,545	2,174	May, 1920
***Putnam**	5,287	3,545	2,174	Sept., 1919
Shortsville	5,227	3,577	2,201	July, 1919
St. Johns Co	5,227	3,577	2,201	July, 1919
Waco	5,256	3,545	2,174	Sept., 1919
***Woodmansie**	5,253	3,283	1,996	Aug., 1919
Located at New Orleans, La.				
***Farnam**	5,125	3,283	2,000	May, 1919
Minnewawa	5,340	3,283	2,000	Dec., 1919
St. Augustine	5,204	3,283	2,000	June, 1919
***Tekoa**	5,340	3,283	1,992	Apr., 1920
Tuladi	5,340	3,283	2,000	Feb., 1920
Located at James River, Va.				
Agawam	5,085	3,282	1,958	Oct., 1918

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*
Alcona	5,070	3,545	2,179	Mar., 1919
Allies	5,187	3,658	2,256	May, 1919
***Anthracite Brdg**	5,340	3,283	2,000	May, 1920
***Asquam**	5,253	3,545	2,174	Aug., 1919
Assinippi	5,253	3,545	2,174	Sept., 1919
Bethlehem Bridge	5,196	3,545	2,179	July, 1919
Boston Bridge	5,204	3,257	1,928	July, 1919
***Bound Brook**	5,196	3,283	2,000	July, 1919
Brasher	5,196	3,256	1,980	July, 1919
Cambridge	5,262	3,283	2,000	Aug., 1919
Chattanooga	5,204	3,545	2,179	May, 1919
***Clark Mills**	5,287	3,283	2,000	Oct., 1919
Consort	5,192	3,285	2,002	May, 1919
***Continental Bridge**	5,287	3,283	2,000	Oct., 1919
Cook	5,295	3,287	1,998	Nov., 1919
Coquitt	5,293	3,283	1,996	Nov., 1919
Coskata	5,300	3,257	1,978	Dec., 1919
Dade County	5,200	3,283	2,000	July, 1919
Decatur Bridge	5,105	3,658	2,256	Jan., 1919
***Des Moines Bridge**	5,340	3,545	2,174	Apr., 1920
***East Chicago**	5,340	3,545	2,174	Apr., 1920
***Federal Bridge**	5,291	3,283	2,000	Oct., 1919
***Haselhurst**	5,340	3,545	2,174	Oct., 1919
***Hico**	5,069	3,283	2,001	Apr., 1919
Hillsborough Co	5,199	3,286	2,003	June, 1919
***Holyoke Bridge**	5,340	3,545	2,174	May, 1929
***Ingold**	5,105	3,257	2,053	Apr., 1910
Jefferson Co	5,192	3,283	2,000	July, 1919
Jekyl	5,182	3,283	2,004	May, 1919
Johnson City	5,196	3,370	2,065	July, 1919
Lordship Manor	5,273	3,275	1,996	Sept., 1919

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*
Masca	5,187	3,286	2,002	May, 1919
Massillon Brdg.	5,075	3,545	2,174	Dec., 1919
Montgomery	5,196	3,283	2,001	June, 1919
Mt. Vernon Bridge	5,075	3,545	2,179	Apr., 1919
National Bridge	5,182	3,545	2,179	May, 1919
Nesco	5,199	3,283	2,000	May, 1919
***Neshobee**	5,340	3,545	2,174	June, 1920
***New England**	5,340	3,545	2,174	Apr., 1920
Passaic Bridge	5,180	3,283	2,000	May, 1919
Pawtucket	5,204	3,283	1,996	Aug., 1919
Phoeix Bridge	5,095	3,283	2,000	Apr., 1919
***Riverside Brdg.**	5,340	3,545	2,174	Mar, 1920
Schuylkill Brdg.	5,340	3,283	2,000	May, 1920
Tona	5,340	3,545	2,174	Jan., 1920
Tonesit	5,340	3,545	2,174	Mar., 1920
***Virginia Bridge**	5,340	3,283	2,000	Apr., 1920
Wallkill	5,204	3,283	2,000	July, 1919
Located at Mobile, Ala.				
Anniston	5,191	3,545	2,179	June, 1919
Northwestern Bridge	5,300	3,283	2,000	Dec., 1919
Located at Orange, Tex.				
Calno	5,204	3,283	2,000	July, 1919
Cushnet	5,300	3,545	2,184	Dec., 1919
Cuttyhunk	5,300	3,545	2,174	Dec., 1919
Fourth Alabama	5,273	3,283	2,000	Sept., 1919
Knoxville	5,196	3,283	2,001	June, 1919
LackawannaBdg	5,296	3,545	2,174	Oct., 1919
***Louisville Brdg.**	5,192	3,283	2,000	June, 1919
***Noddle Island**	5,340	3,257	1,978	May, 1920

* Vessels equipped with Falk Gears.





Design Number 1038

5,300 D. W. T. STEEL CARGO

Hull Particulars

Builder	Mobile Shipbuilding Company
Type of construction	Transverse
Superstructures	Bridge, poop and forecastle
Number of holds	4 and deep tanks
Number of decks	1 and tween decks in number 1 and number 4 holds
Number and size of hatches	2:29′ 3″ x 18′; 1:9′ x 13′ 7½″ 2:24′ 9″ x 18′
Type of bulwarks	Solid
Cargo booms, number and lift	8-5 ton; 2-1½ ton
Length overall	335′ 6″
Length B. P.	324′ 0″
Beam, moulded	46′ 0″
Depth, moulded	27′ 8″
Draft, load summer	23′ 0 $\frac{11}{16}$″
Displacement at load draft	7,560 tons
Block coefficient	.789
Prismatic coefficient	.793
Bale capacity, holds, 'tween decks and hatches	200,397 cubic feet
Bale capacity, deep tanks	10,148 cubic feet
Bale capacity, bridge	21,720 cubic feet
Total bale capacity	232,265 cubic feet
Total grain capacity	266,031 cubic feet

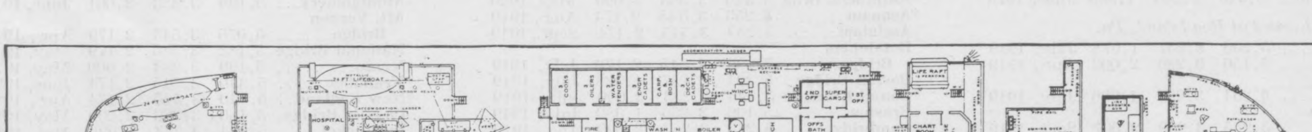
Cubic feet per long ton	Fresh water 36	Salt water 35	Fuel oil 40
Fore peak, tons	...	144	...
After peak, tons	...	95	...
Inner bottoms, tons	151	...	619
Deep tanks, tons (cargo, ballast or oil)	...	384	...
Total	151	623	619

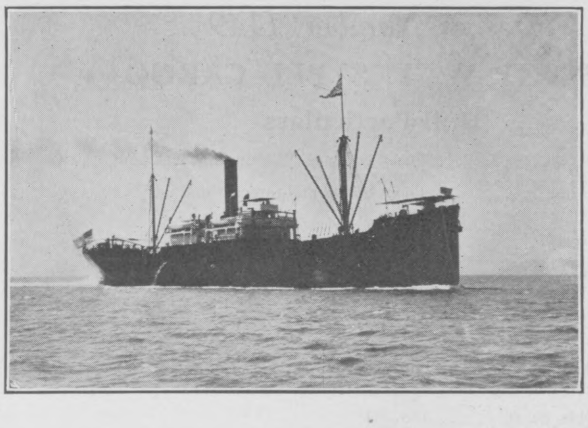
VESSELS AVAILABLE

Name	D.W.T.	Gross	Net	Date Built	Location
Capital of Nebraska	5,311	3,545	2,179	July, 1920	Arlington, S. I.
Minooka	5,238	3,545	2,179	Feb., 1920	James River, Va
Oklahoma City	5,314	3,545	2,179	June, 1920	"
Houston	5,296	3,545	2,179	Oct., 1920	"
Atlanta of Texas	5,231	3,545	2,179	Oct., 1920	"
City of Lordsburg	5,303	3,545	2,179	Sept., 1920	"
Hutchinson	5,219	3,545	2,179	May, 1920	New Orleans, La
Moshico	5,273	3,658	2,256	Dec., 1919	Orange, Texas

Machinery Particulars

Number and type of boilers	2 Ward W. T.
Total boiler heating surface	5,994 square feet
Working pressure, pounds gauge	200
Main engine	22″–37½″–60″ x 42
Designed H. P. and R. P. M.	1600 I. H. P. at 80
Designed sea speed, knots	10½
Length of engine and boiler rooms	47′ 3″
Diameter and length of propeller shaft	13″ x 19′ 1⅜″
Diameter and length of line shaft	5 11½″ x 18′ 10½″
Diameter and length of thrust shaft	12¼″ x 11′ 8¼″
Total length of shafting	125′ ⅛″
Shaft center above base line, at stern	8′ 10″
Shaft center above base line, at engine coupling	8′ 10″
Engine coupling above tank top	5′ 10″
Engine coupling from after bulkhead	3′ 2¼″ for'd
Maximum propeller diameter allowed by stern frame	15′ 9″





Design Number 1043

5,100 D. W. T. STEEL CARGO

Hull Particulars

Builder	Hanlon Dry Dock and Shipbuilding Co.
Type of construction	Transverse framing
Superstructures	Poop, bridge and forecastle
Number of holds	4 and deep tanks
Number of decks	2
Number and size of hatches	1:27′ x 16′; 3:24′ 9″ x 16′; 1:11′ 3″ x 16′
Type of bulwarks	Solid
Cargo booms, number and lift	4-5 ton; 6-3 ton; 1-30 ton
Length over all	332′ 9″
Length B. P.	320′ 9″
Beam, moulded	46′ 0″
Depth, moulded	26′ 9″
Draft, load summer	22′ 1 $\frac{9}{16}$″
Displacement at load draft	7,489 tons
Block coefficient	.802
Prismatic coefficient	.82
Bale capacity, holds, 'tween decks and hatches	169,568 cubic feet
Bale capacity, deep tanks	23,089 cubic feet
Bale capacity, bridge	19,415 cubic feet
Bale capacity, total	212,072 cubic feet
Grain capacity, total	238,746 cubic feet

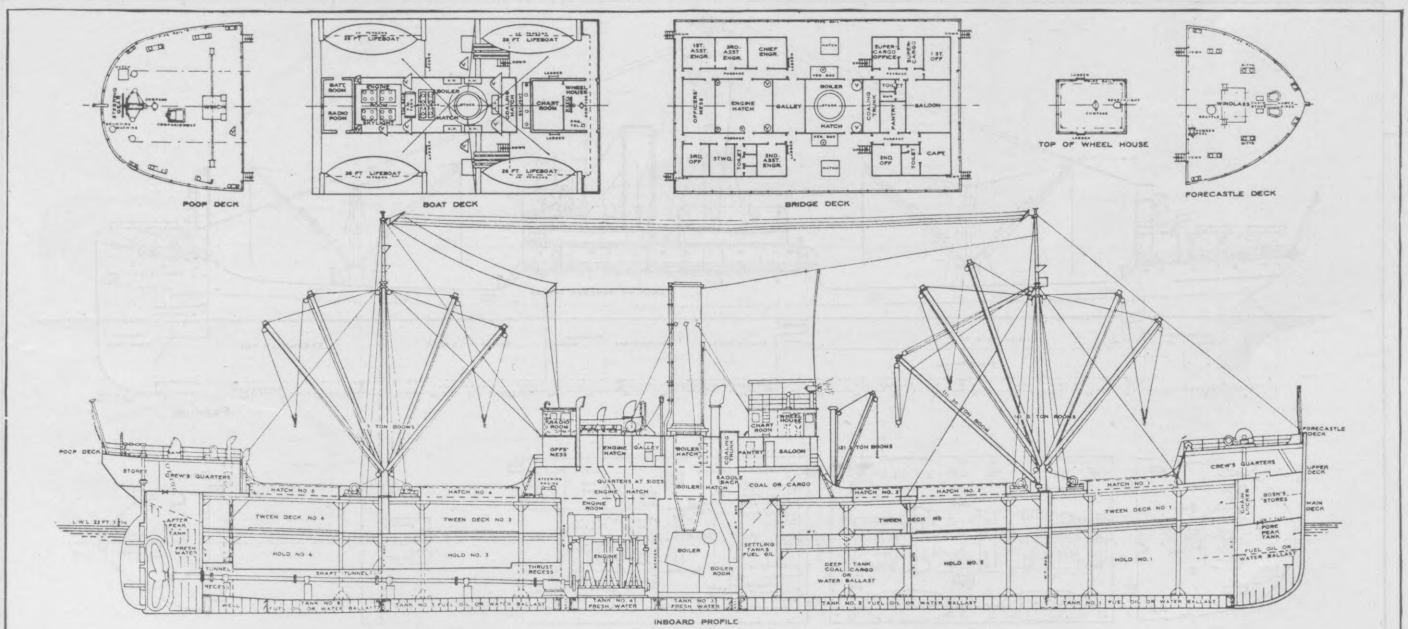
	Fresh water	*Salt water*	*Fuel oil*
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	...	94	...
After peak, tons	...	104	...
Inner bottoms, tons	134	...	466
Deep tanks (cargo, ballast or oil), tons	...	721	...
Settling tanks, tons	...	...	136
Side bunkers, tons	...	...	176
Total	134	919	778

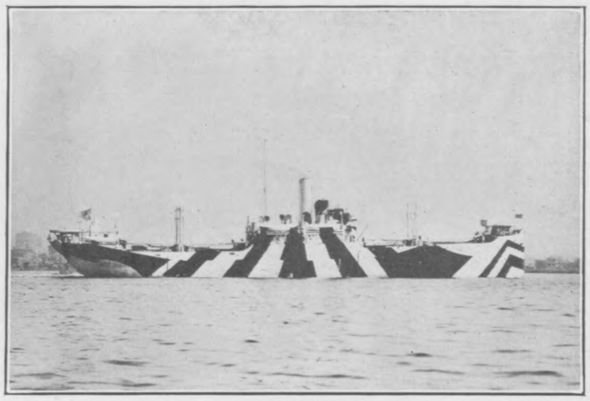
VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
Derblay	5,118	3,475	2,065	Sept., 1920	Seattle, Wash
Depere	5,136	3,475	2,063	Aug., 1920	"
Memnon	5,129	3,329	2,012	Feb., 1921	"
Jeptha	5,127	3,333	2,105	Oct., 1920	"

Machinery Particulars

Number and type of boilers	3 Foster W. T.
Total boiler heating surface	7,200 square feet
Working pressure, lbs. gauge	200
Main engine	24″, 39″, 65″ x 42″, Allis Chalmers Co.
Designed horsepower and R. P. M.	1,630 I. H. P. at 80
Designed sea speed, knots	11
Length of engine and boiler rooms	49′ 6″
Diameter and length of propeller shaft	14″ x 16′ 3¼″
Diameter and length of line shaft	4 12½″ x 22′ 0″
Diameter and length of thrust shaft	13″ x 11′ 4¾″
Total length of shafting	115′ 8″
Shaft center above base line, at stern	9′ 1″
Shaft center above base line, Eng. coupling	6′ 10½″
Engine coupling above tank top	3′ 9″
Engine coupling from after bulkhead	4′ 2¼″ forward
Maximum propeller diameter allowed by stern frame	16′ 9″





Design Number 1149

3,900 D. W. T. STEEL CARGO

Hull Particulars

Builder	Pusey & Jones Wilmington, Del.
Type of construction	Transverse
Superstructures	Poop, bridge and forecastle
Number of holds	4
Number of decks	1
Number and size of hatches	4:20′ x 30″
Type of bulwarks	Solid
Cargo booms, number and lift	8-5 ton
Length overall	312′ 0″
Length B. P.	300′ 0″
Beam, moulded	44′ 0″
Depth, moulded	22′ 3″
Draft, load summer	19′ 0″
Displacement at load draft	5,665 tons
Block coefficient	.791
Prismatic coefficient	.817
Bale capacity, cargo holds, cu. ft.	148,504
Bale capacity, reserve bunker cu. ft.	9,686
Bale capacity, bridge, cu. ft.	9,917
Bale capacity, total cu.ft.	168,117
Grain capacity, total, cu. ft.	182,505
Permanent bunker	202 tons
Reserve bunker	498 tons

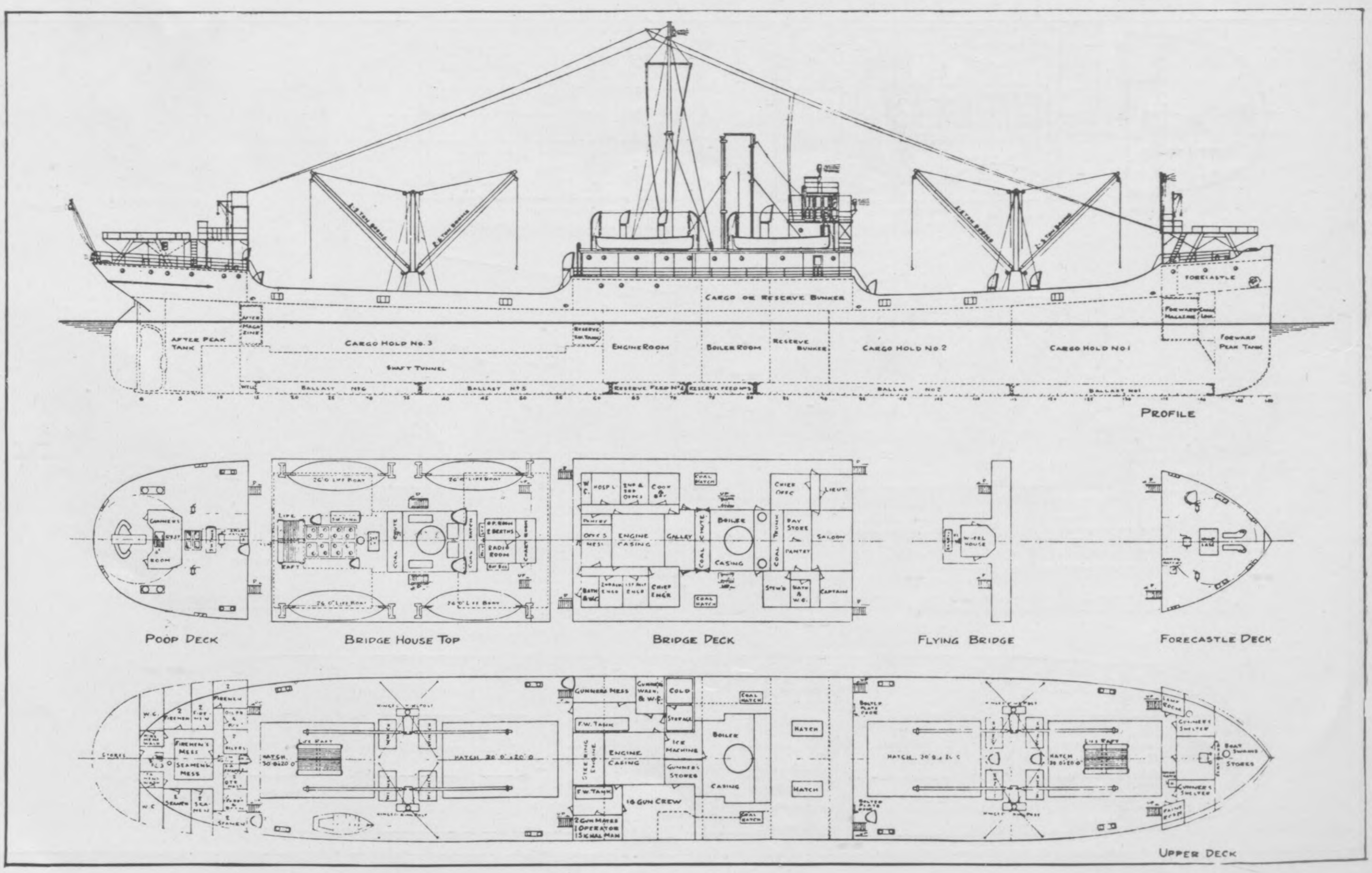
	Fresh water	*Salt water*	*Fuel oil*
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	...	104	...
After peak, tons	...	137	...
Inner bottoms, tons	119	680	...
Total	119	821	...

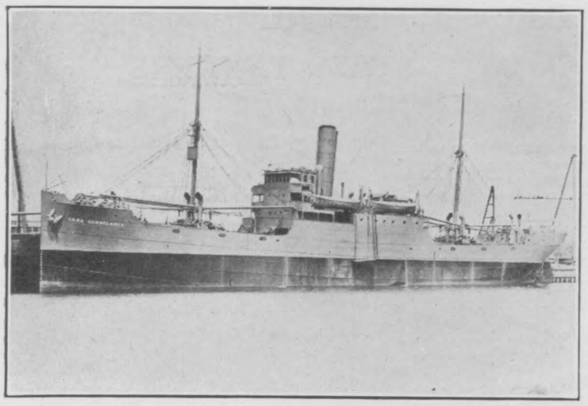
VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
Middlebury	3,909	2,585	1,469	July, 1918	Orange, Texas
Waukesha	3,909	2,585	1,469	May, 1918	James River, Va.

Machinery Particulars

Number and type of boilers	2 Scotch
Total boiler heating surface	4,258 sq. ft.
Working pressure, lbs. gauge	200
Main engine	DeLaval geared turbine
Designed H. P. and R. P. M.	1.400 S. H. P. at 90
Designed sea speed, knots	10
Length of engine and boiler rooms	42′ 0″
Diameter and length of propeller shaft	12½″ x 17′ 1¾″
Diameter and length of line shaft	5 10½″ x 15′ 9½″; 1 10½″ x 15′ 11
Diameter and length of thrust shaft	10½″ x 9′ 10½″
Total length of shafting	121′ 10¾″
Shaft center above base line at stern	8′ 4″
Shaft center above base line at engine coupling	8′ 4″
Engine coupling above tank top	5′ 0″
Engine coupling from after bulkhead	10½″ for'd
Maximum propeller diameter allowed by stern frame	15′ 3″





Design Number 1020

3,600 D. W. T. STEEL CARGO

Hull Particulars

Builder	Saginaw Shipbuilding Co.
Type of construction	Transverse framing
Superstructures	Poop, bridge and forecastle
Number of holds	2
Number of decks	1
Number and size of hatches	4:18' x 22
Type of bulwarks	Solid
Cargo booms, number and lift	5-5 ton
Length overall	261' 0"
Length B. P.	251' 0"
Beam, moulded	43' 6"
Depth, moulded	24' 2½"
Draft, summer load	21' 3"
Displacement at load draft	5,280 tons
Block coefficient	.805
Bale capacity, cargo holds	149,958 cubic feet
Bale capacity, bridge	11,455 cubic feet
Total bale capacity	161,413 cubic feet
Total bale capacity	161,413 cubic feet
Total grain capacity	157,467 cubic feet
Permanent bunkers	244 tons
Reserve	266 tons

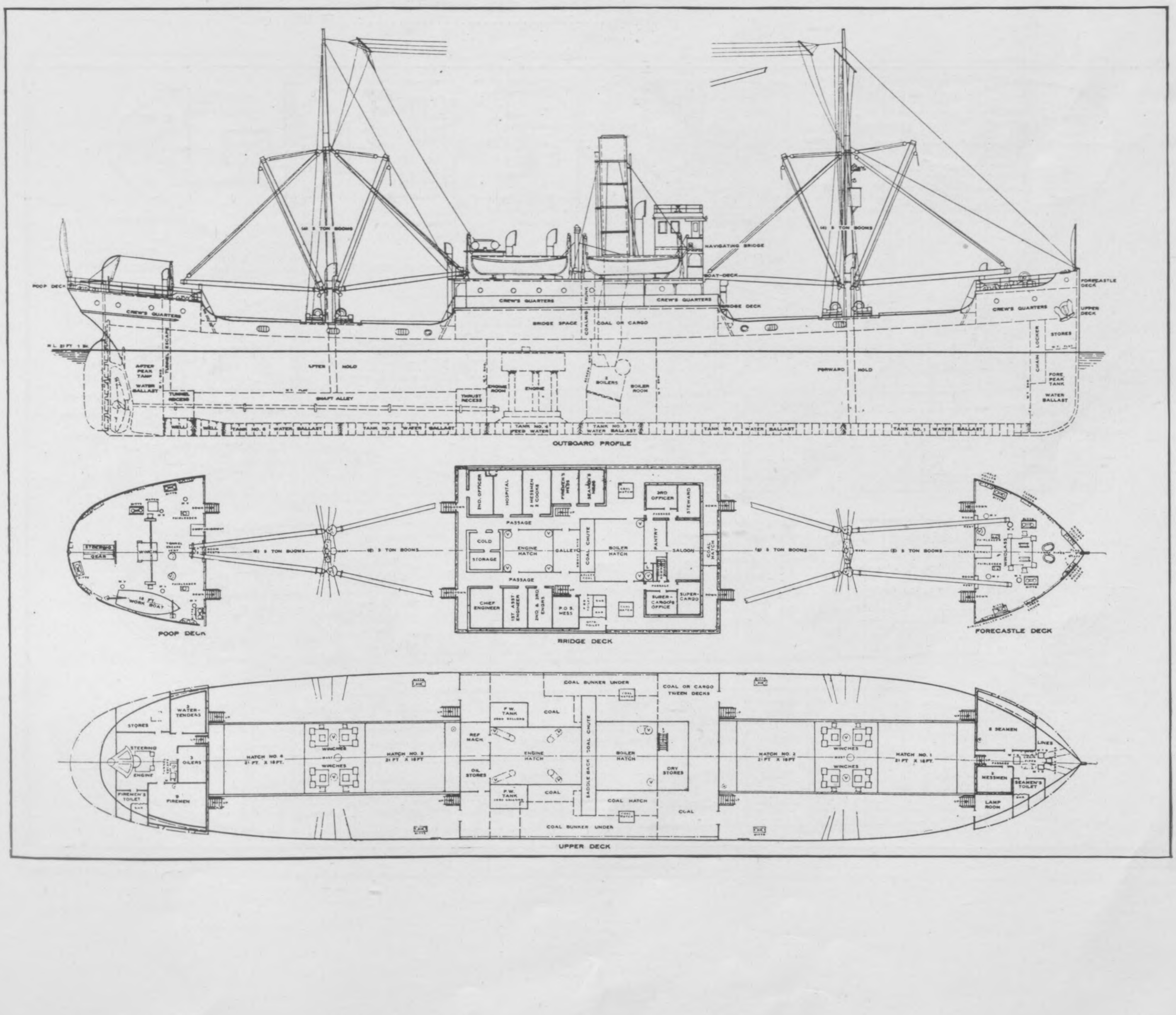
	Fresh water	*Salt water*	*Fuel oil*
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	..	37	..
After peak, tons	..	79	..
Inner bottoms, tons	71	388	..
Total tons	71	504	..

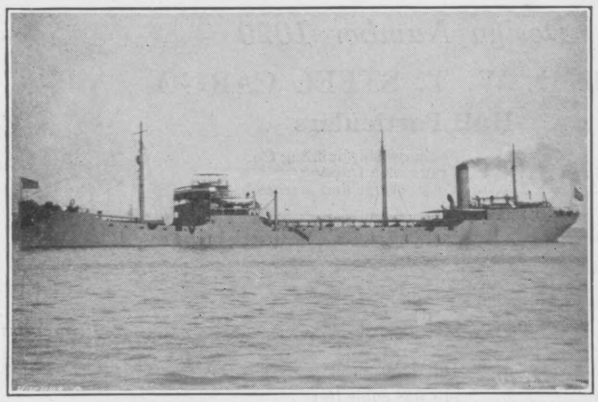
VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
Contract No. **61**					
Lake Belnona	3,540	2,350	1,418	Nov., 1918	James River, Va.
Lake Osweya	3,515	2,416	1,432	Sept., 1918	"
Lake Pachuta	3,540	2,416	1,464	Aug., 1918	"
Lake Winooski	3,515	2,416	1,432	Nov., 1918	"
Lake Licoco	3,545	2,350	1,418	Mar., 1919	Jones Point, N.Y.
Lake Lilicusun	3,545	2,350	1,418	Apr., 1919	"
Contract No. **181**					
Lake Cannonsburg	3,559	2,352	1,404	Sept., 1919	Jones Point, N.Y.
Lake Candelaria	3,559	2,352	1,404	July, 1919	"
Lake Canaveral	3,559	2,354	1,404	May, 1919	James River, Va.
Lake Fear	3,559	2,344	1,399	Oct., 1919	"
Lake Girardeau	3,550	2,344	1,399	Oct., 1919	"
Lake Saba	3,559	2,352	1,401	May, 1919	"

Machinery Particulars

Number and type of boilers	2 Wickes, W. T.	
Total boiler heating surface	5,190 sq. ft.	
Working pressure, lbs. gauge	200	
	Contract No. 61	*Contract No. 181*
Main engine	22"–37½"–60" x 42"	19"–32"–56" x 36"
Designed H. P. and R. P. M.	1,600 I. H. P. at 80	1,400 I. H. P. at 92
Designed sea speed, knots	10	9.5
Length of engine and boiler rooms	44' 0"	44' 0"
Diameter and length of propeller shaft	13" x 15' 7¼"	11⅞" x 15' 5"
Diameter and length of line shaft	4:11⅛" x 18' 7½"	4:10" x 19' 0"
Diameter and length of thrust shaft	11¾" x 9'10¾"	10¾" x 7' 8"
Total length of shafting	100' 0"	99' 1"
Shaft center above base line, at stern	7' 11"	7' 8½"
Shaft center above base line, at engine coupling	7' 11"	6' 4 7-16"
Engine coupling above tank top	4' 11"	3' 4 7/16"
Engine coupling from after bulkhead	3' 4¾" for'd	2' 8" for'd
Maximum propeller diameter allowed by stern frame	14' 9"	14' 3"





Design Number 1059

10,300 D. W. T. STEEL TANKERS

Hull Particulars

Builder	Baltimore Dry Dock & Shipbuilding Co.
Type of construction	Longitudinal framing
Superstructures	Forecastle, bridge and long poop
Type of bulwarks	Solid
Cargo booms, number and lift	2-5 ton
Length overall	450′ 0″
Length B. P.	430′ 0″
Beam, moulded	59′ 0″
Depth, moulded	33′ 3″
Draft, load summer	25′ 4 1/8″
Displacement at load draft	14,760 tons
Block coefficient	.802
Total capacity, main cargo tanks	72,670 bbls. of 42 gals.
Total capacity, summer or wing tanks	10,476 bbls. of 42 gals.
Total cargo, oil capacity	83,146 bbls. of 42 gals.
Dry cargo, for'd hold and tween decks	35,883 cubic feet

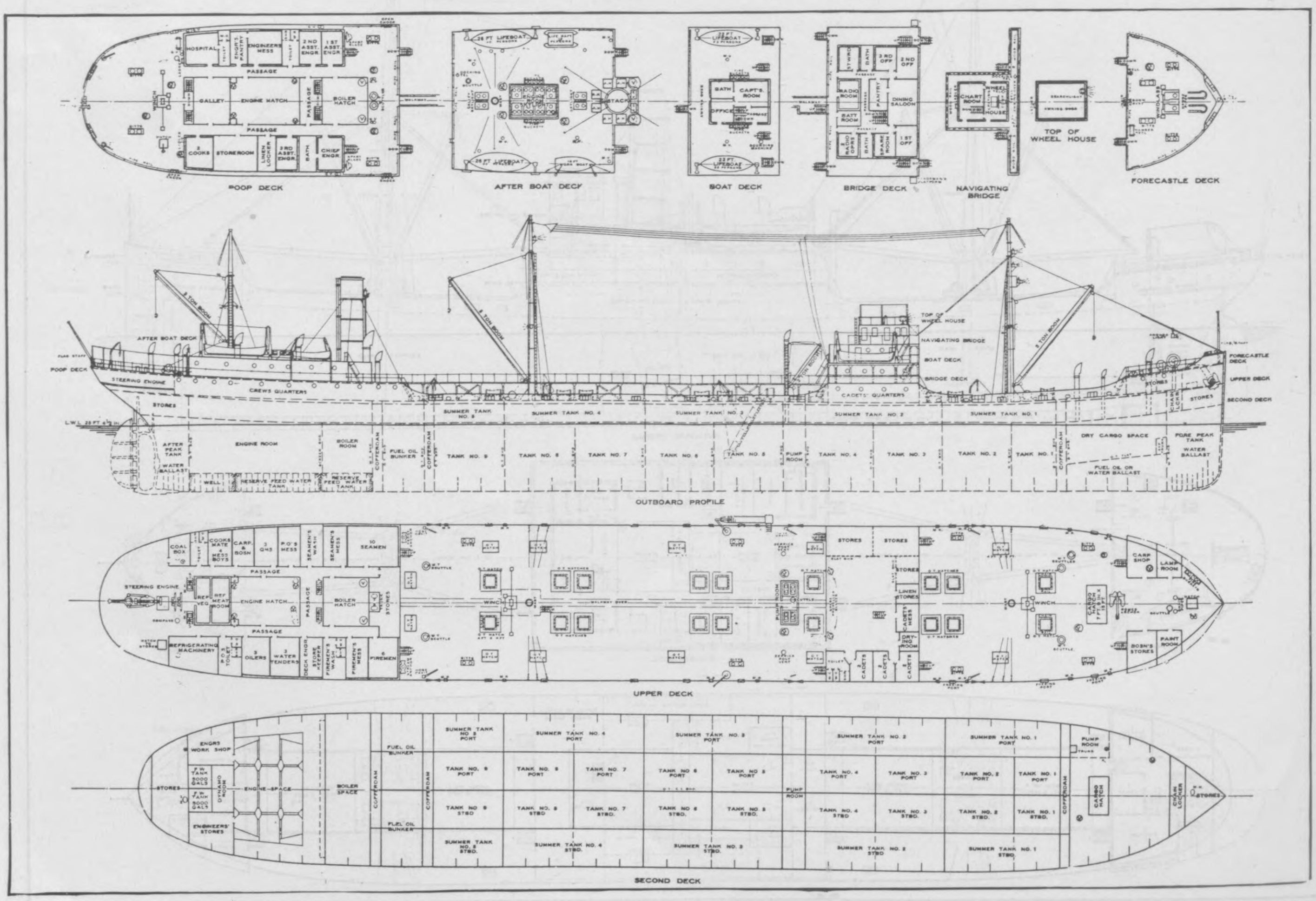
	Fresh water	Salt water	Fuel oil
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	...	232	...
After peak, tons	...	117	...
Inner bottoms, tons	255	...	...
Deep tanks for'd, tons (ballast or oil)	...	455	...
Cross bunker, tons	...	...	768
After cofferdam, tons (reserve)	...	...	196
Total tons	255	804	964

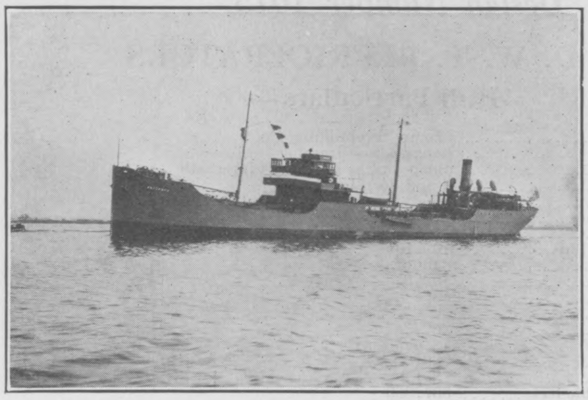
VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
District of Columbia	10,250	7,641	4,677	Fe.121 9 eat gn	Ob ip „
Tuxpanoil	10,250	7,245	4,398	Mar., 1921	
Tulsagas	10,250	7,245	4,398	May, 1921	“

Machinery Particulars

Number and type of boilers	3 Scotch
Total boiler heating surface	7,926 sq. ft.
Working pressure, lbs. gauge	200
Main engine	Geared cross-compound Parsons turbines
Designed H. P. and R. P. M.	2,800 S. H. P. at 90
Designed sea speed, knots	10
Length of engine and boiler rooms	54′ 0″
Diameter and length of propeller shaft	14 3/8″ x 20′ 5 1/8″
Diameter and length of line shaft	12 1/2″ x 7′ 0″; 12 1/2″ x 17′ 6″
Diameter and length of thrust shaft	None
Total length of shafting	44′ 11 1/8″
Shaft center above base line, at stern	10′ 3″
Shaft center above base line, Eng.lcoupling	10′ 3″
Engine coupling above tank top	3′ 11″
Engine coupling from after bulkhead	26′ 11 3/8″
Maximum propeller diam. allowed by stern frame	19′ 0″





Design—Pusey & Jones: 1—6

7,000 D. W. T. STEEL TANKERS

Hull Particulars

Builders	Pusey & Jones Co., Wilmington, Del.
Type of construction	Longitudinal framing
Superstructures	Forecastle, bridge and long poop
Type of bulwarks	Rail
Number and lift of cargo booms	2-3 ton
Length overall	380′ 0″
Length B. P.	365′ 0″
Beam, moulded	50′ 9″
Depth, moulded	31′ 3″
Draft, load summer	24′ 5″
Displacement at load draft	10,225 tons
Block coefficient	794
Total capacity of main cargo tanks	51,516 bbls. of 42 gals.
Total capacity of summer or wing tanks	5,922 bbls. of 42 gals.
Total cargo, oil capacity	57,438 bbls. of 42 gals.
Dry cargo: Wing tanks, for'd hold and tween decks	48,170 cubic feet

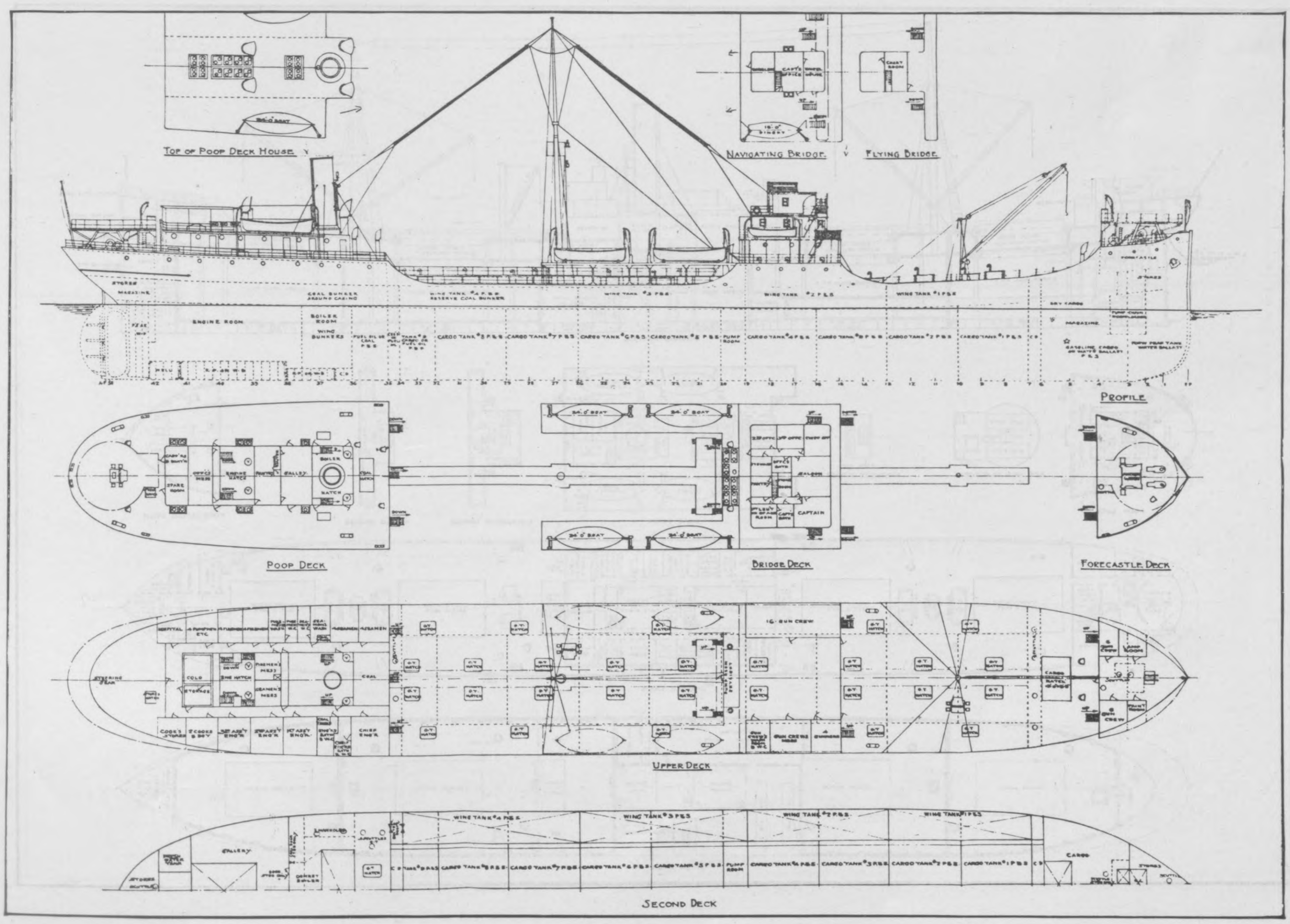
	Fresh water	Salt water	Fuel oil
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	...	154	...
After peak, tons	...	32	..
For'd deep tanks, tons (ballast or oil)	...	355	...
Inner bottoms, tons	134	...	347
After cofferdam, tons (reserve)	...	...	138
Total tons	134	541	485

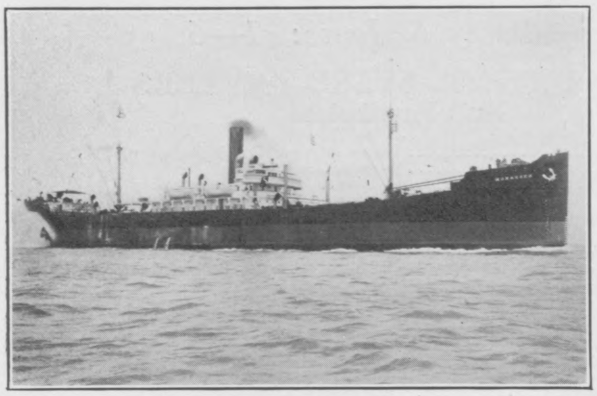
VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
Bessemer	7,029	4,923	3,459	June, 1919	Mobile, Ala.
Brandywine	7,047	4,969	3,456	Nov., 1918	"
Chestnut Hill	7,028	4,935	2,970	Mar., 1919	"
John M. Connelly	6,997	4,939	2,969	May, 1919	"
Sharon	7,029	4,936	3,457	Sept., 1919	"

Machinery Particulars

Number and type of boilers	3 Scotch
Total boiler heating surface	5,203 sq. ft.
Working pressure, lbs. gauge	210
Main engine	Geared turbine — General Electric Co.
Designed H. P. and R. P. M.	2,400 S. H. P. at 90
Designed sea speed, knots	11
Length of engine and boiler rooms	66′ 0″
Diameter and length of propeller shaft	13 11/16″ x 14′ 2¾″
Diameter and length of line shaft	None
Diameter and length of thrust shaft	12½″ x 16′ 9″
Total length of shafting	30′ 11¾″
Shaft center above base line, at stern	10′ 0″
Shaft center above base line, Eng. coupling	10′ 0″
Engine coupling above tank top	5′ 0″
Engine coupling from after bulkhead	16′ 9″ for'd
Maximum propeller diam. allowed by stern frame	18′ 6″





Design Number 1015

8,400 D. W. T. REFRIGERATORS

Hull Particulars

Builder	Moore Shipbuilding Co.
Type of construction	Longitudinal framing
Superstructures	Poop, bridge house and forecastle
Number of holds	4 and deep tanks
Number of decks	2
Number and size of hatches	4:31′ 5″ x 18′ 5″; 1:6′ 5″ x 18′ 9″
Type of bulwarks	Rail
Cargo booms, number and lift	10:3 ton
Length overall	416′ 6″
Length B. P.	402′ 6″
Beam, moulded	53′ 0″
Depth, moulded	34′ 6″
Draft, load summer	26′ 4¾″
Displacement at load draft	12,625 tons
Block coefficient	.801
Prismatic coefficient	.811
Insulated cargo space, cubic feet	307,869
Total bale capacity, cubic feet	346,021

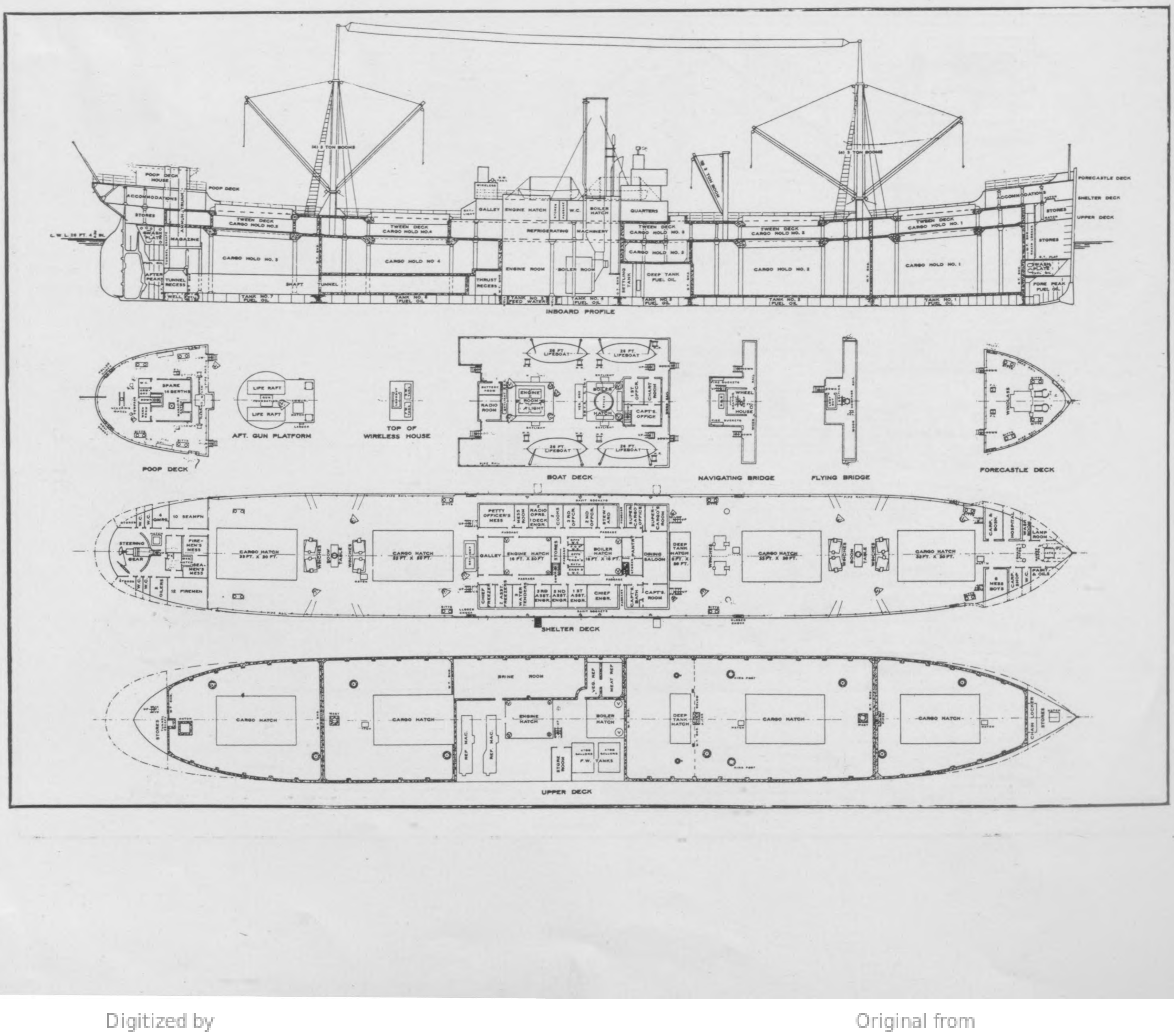
	Fresh water	*Salt water*	*Fuel oil*
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	...	73	...
After peak, tons	...	49	...
Inner bottoms, tons	81	...	1,060
Deep tanks, tons (Cargo, Ballast or Oil)	...	546	...
Settling tanks, tons	...	...	37
Total, tons	81	668	1,097

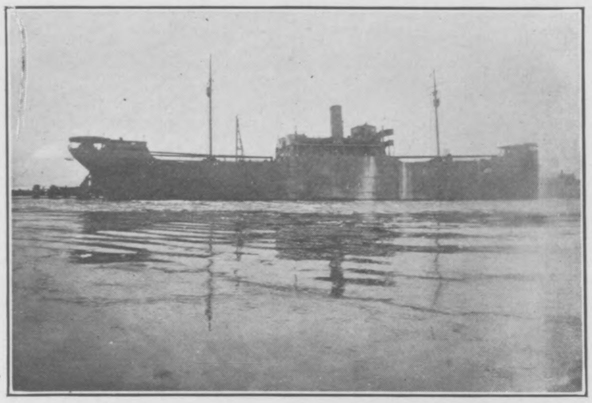
VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
Guimba	8,370	6,100	4,545	June, 1919	Hog Island, Pa.
Oskawa	8,370	6,100	4,539	Dec., 1919	Hog Island, Pa.

Machinery Particulars

Number and type of boilers	4 Heine, W. T.
Total boiler heating surface	11,132 square feet
Working pressure, lbs. gauge	225
Main engines	GUIMBA: Westinghouse, Geared, Cross Compound OSKAWA: General Electric, Geared, Single
Designed H. P. and R. P. M	2,800 S. H. P. at 90
Designed sea speed, knots	11
Length of engine and boiler rooms	50′ 0″
Diameter and length of propeller shaft	14¾″ x 16′ 2¾″
Diameter and length of line shaft	7 13⅜″ x 18′ 7″
Diameter and length of thrust shaft	13⅜ x 11′ 1″
Total length of shafting	157′ 4¾″
Shaft center above B. L. at stern	9′ 2″
Shaft center above B. L., Engine coupling	9′ 2″
Engine coupling above tank top	5′ 7″
Engine coupling from after bulkhead	26″ for'd
Maximum propeller diameter allowed by stern frame	16′ 9″
Cargo refrigerating machinery	2:80 ton York Manufacturing Co. Steam-driven CO 2 compressors and brine system





Design Number—Balt. 82—86

5,600 D. W. T. STEEL REFRIGERATORS

Hull Particulars

Builder	Baltimore S. B. & D D. Co.
Type of construction	Longitudinal framirg
Superstructures	Poop, bridge and forecastle
Number of holds	4
Number of decks	2
Number and size of hatches	1:30′ x 20′; 1:31′ x 20′; 2:24′ x 18
ype of bulwarks	Rail
Cargo booms, number and lift	8:5 ton
Length overall	353′ 3″
Length B. P	340′ 0″
Beam, moulded	49′ 0″
Depth, moulded	28′ 7¾″
Draft, load summer	23′ 1½″
Displacement at load draft	8,830 tons
Block coefficient	.821
Prismatic coefficient	.828
Insulated cargo space	181,765 cubic feet
Cross bunker, hold and 'tween ecks	52,793 cubic feet
Bridge space	3,870 cubic feet
Permanent bunkers	263 tons

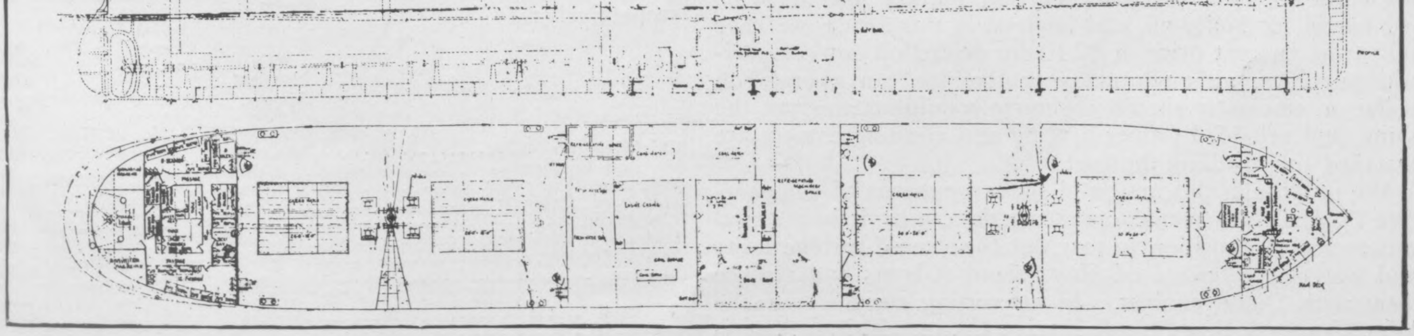
	Fresh water	*Salt wa er*	*Fuel oil*
Cubic feet per long ton	*36*	*35*	*40*
Fore peak, tons	...	98	...
After peak, tons	128	...	...
Inner bottoms, tons	120	671	...
Total, tons	248	769	...

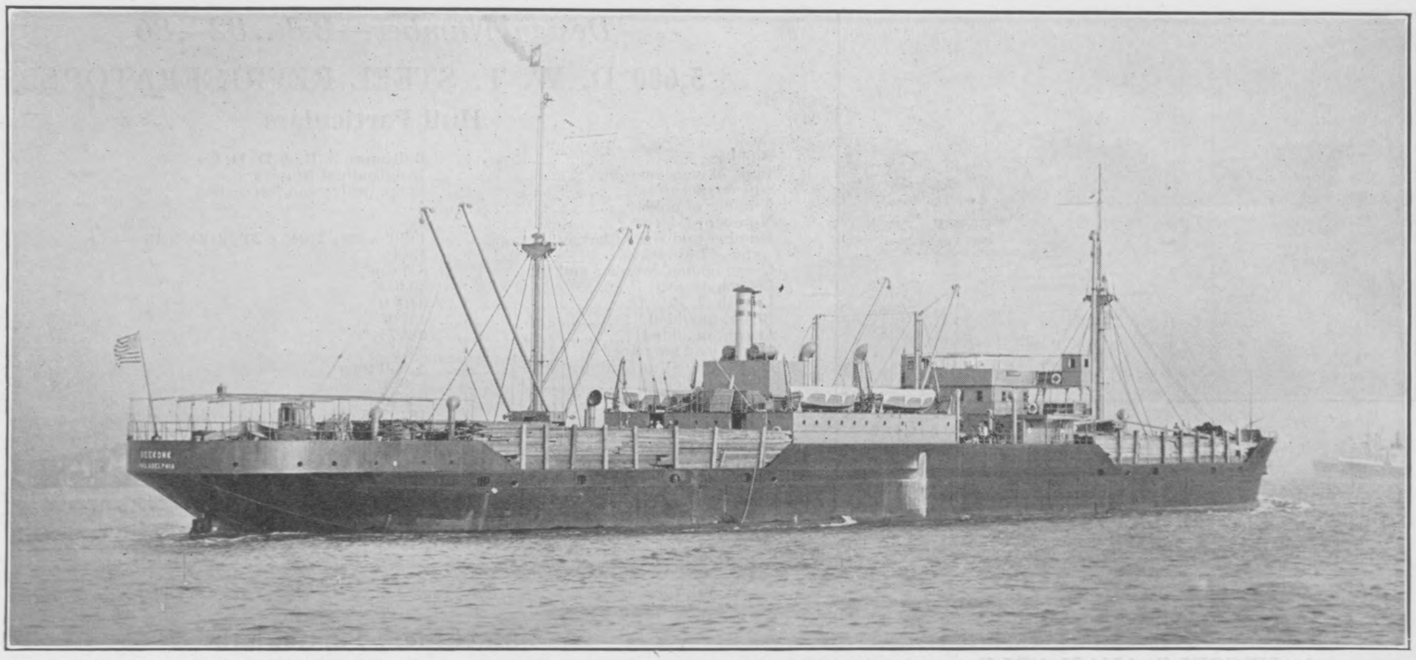
Machinery Particulars

Number and type of boilers	3 Scotch	
Total boiler heating surface	5,100 square feet	
Working pressure, lbs. gauge	195	
	Luella, only	*All others*
Main engine	General Electric Geared Turbine	Westinghouse Geared Turbine
Designed H. P. and R. P. M	1,800 S. H. P. at 90	1,800 S. H. P. at 90
Designed sea speed, knots	10.5	10.5
Length of engine and boiler rooms	44′ 0″	44′ 0″
Diameter and length of propeller shaft	12½″ x 15′ 1″	12½″ x 15′ 1″
Diameter and length of line shaft	4:11⅛″ x 22′ 6″ 1:11⅛″ x 28′ 5″	5:11⅛″ x 22′ 6″
Diameter and length of thrust shaft	None	11⅝″ x 6′ 11″
Total length of shafting	133′ 6″	134′ 6″
Shaft center above base line at stern	8′ 6″	8′ 6″
Shaft center above base line at engine coupling	8′ 6″	8′ 6″
Engine coupling above tank top	5′ 2″	5′ 2″
Engine coupling from after bulkhead	....	12″ For'd
Maximum propeller diameter allowed by stern frame	15′ 6″	15′ 6″
Refrigerating machinery	2:60 ton, CO 2	Steam-Driven compressors, Frick Co.

VESSELS AVAILABLE

Name	*D.W.T.*	*Gross*	*Net*	*Date Built*	*Location*
Luella	5,612	4,152	2,540	May, 1918	Hog Island, Pa.
North Pole	5,544	4,130	2,501	Dec., 1918	Jones Point, N Y.
Polar Sea	5,558	4,111	2,500	Aug., 1918	"
South Pole	5,520	4,116	2,492	Nov., 1918	"





Hog Island type ship "Seekonk" after conversion to Diesel power. The big deck load of lumber is only possible because of her "island platforms" on which are mounted the electric winches.

A Hog Island Class-A Ship Conversion and Its Results

Changes Made to the "Seekonk," Formerly Propelled by a Reduction-Geared Turbine, Now Equipped with a Single-Screw, Single-Acting, Four-Cycle Diesel Engine. Resultant Possible Operating Economies Amount to $148,902 per Year Against Higher Capital Charges of $16,456 if Compared with Steamer Bought at $30 per d.w. Ton.

(*Verified by United American Lines, Operators.*)

SHIPOWNERS familiar with America's wartime merchant-marine building generally regard the Hog Island A-class hulls as being of excellent construction, and of a size for which there are uses in many ocean trades. It has been shown that when converted to more economical power these boats are capable of competing with the most successful European craft of their tonnage. They have good under-water form, so are easy to drive in moderate weather. Fortunately, a certain amount of information is available regarding the average performances on 250 voyages with drafts of 19 ft. to 24 ft. of 70 steamers of this class, which can be used for comparison purposes with the *Seekonk* of the United American Lines — the first of this class to be converted to Diesel power.

These 70 oil-fired *steamers* averaged the following results on 21 ft. 8 in. mean draft:

Sea Speed *Loaded*	10.3 knots
Daily Fuel Consumption *at Sea*	29 tons
Daily Fuel Consumption *in Port*	6½ tons
Daily Fuel Cost *at Sea*	$355.25
Daily Fuel Cost *in Port*	$79.62
Fuel bill (at current prices) if 240 days at sea	$85,260
Fuel bill (at current prices) if 125 port days	$9,952.50
No. of Engine-room crew	16 men

To make the fuel bills in accordance with today's operating costs we have taken the current market rate of $1.75 per barrel for boiler-oil, and later on in this article we have taken the current price of $2.10 for Diesel-oil for comparison purposes, although many motorships can operate on boiler-oil efficiently should economic conditions warrant the same, and provided proper heating and cleaning devices are installed for handling the fuel.

We propose in this article to show, by means of comparative figures from actual operating data, why it is a sound economical proposition to tear out the geared-turbine units and water-tube boilers of Hog Island A-boats and replace them with Diesel engines. In converting the *Seekonk* the Wm. Cramp & Son Ship & Engine Co. installed an American-built Burmeister & Wain six-cylinder, 29⅛″ by 59″ single-acting, long-stroke, slow-speed, four-cycle Diesel engine of the air-injection type developing 2,300 i.h.p. at 85 to 90 r.p.m. In addition there are three twin-cylinder, four-cycle auxiliary Diesels of 100 b.h.p. at 400 r.p.m. direct connected to 67 k.w. Diehl generators.

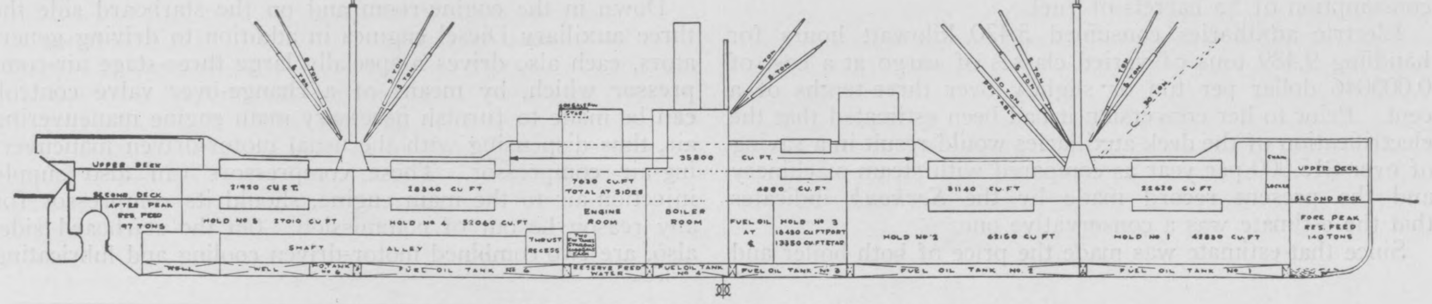
The principal dimensions of the *Seekonk,* as converted, are as follows:

Displacement, *loaded*	11,440 tons
Cargo capacity, *grain*	407,580 cu. ft.
Cargo capacity, *bales*	382,210 cu. ft.
Deck cargo capacity, *lumber*	1,000,000 ft.
Deadweight capacity	7,754 tons
Length *o. a.*	401′ ⅜″
Length *b. p.*	390′ 0″
Breadth, *moulded*	54′ 0″
Depth *to upper deck*	32′ 0″
Draft, *loaded*	24′ 5$\frac{3}{16}$″
Power	2,300 i.h.p.
Fuel-*capacity* (7,456 bbls. or 1,101 tons)	41,862 cu. ft.
Speed, *maximum continuous loaded*	10.7 knots
Speed, *mean-service loaded*	10.25 to 10.5 knots
Engine and Propeller speed	85 to 90 r.p.m.

The *Seekonk* is a complete conversion, as all deck and engine-room machinery has been scrapped and replaced with electrical equipment, excepting the windlass, capstan and refrigerator. These machines were rebuilt to electric drive. Her engine-room crews before and after conversion are, respectively:

	As a Steamer		As a Motorship	
	No. of Men	Approx. Yearly Wages*	No. of Men	Approx. Yearly Wages
Chief-Engineer	1	$3,168	1	$3,300
1st. Asst Engineer	1	2,420	1	2,204
2nd. Asst. Engineer	1	1,980	1	2,040
3rd. Asst. Engineer	1	1,800	1	1,860
Electrician	0	.....	1	1,560
Oilers (or motormen)	3	2,718	4	3,624
Water Tenders	3	2,718	0	.....
Firemen	6	4,716	0	.....
Total	16	$19,520	9	$14,588

*Shipping Board rates. Some private wages are about 10% lower.



Sectional profile drawing of the "Seekonk" before her conversion.

While there now are two men on watch while at sea, one man only attends to the main engine, the other man operating all the auxiliary machinery. Due to the grouping of the principal auxiliaries on the starboard side, and in full view of the operating platform, the vessel is practically a one-man operated job in the engine-room. This arrangement enables an annual wage saving of $4,932 to be made, in addition to $1,533 for food saved at $0.60 per man per day.

When carrying out the work of conversion, structural changes other than with the machinery itself were surprisingly few. The screen bulkhead between the boiler-room and the engine-room was removed, and new foundations constructed for the main and auxiliary machinery. A lubricating-oil drain tank was located in part of the old reserve feed-tank, surrounded by the cofferdam. The deep tank was eliminated and turned into useful cargo space by enlarging No. 3 hold.

The old bulky horseshoe bearing was replaced by a Gibbs type of thrust, lubricated from the main engine system. A new line shaft with line-shaft bearings was required, due to the old shaft not having sufficient diameter. The old tail-shaft, however, was retained, as originally it had been made oversize for the steamer. A new manganese bronze propeller has been supplied of slightly less diameter and solid instead of built-up, as formerly used.

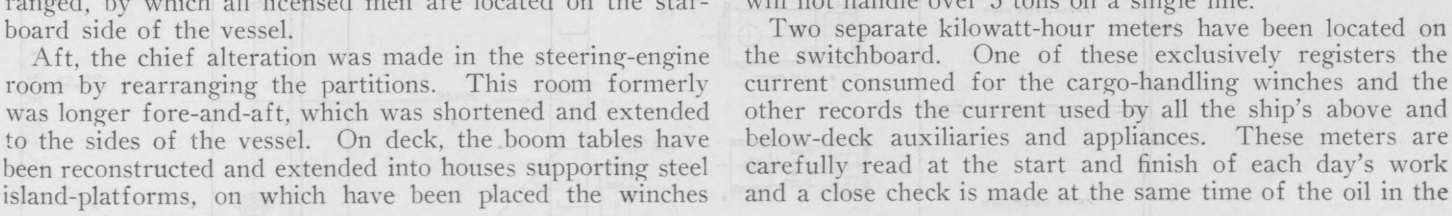
Some changes to the crew's accommodation were considered advisable. The bathroom and toilets, located as a steamer between engine and boiler-room hatches, were moved to the location indicated on accompanying plan, the Chief Engineer being provided with a bath opening into his room. The quarters amidship have been slightly rearranged, by which all licensed men are located on the starboard side of the vessel.

Aft, the chief alteration was made in the steering-engine room by rearranging the partitions. This room formerly was longer fore-and-aft, which was shortened and extended to the sides of the vessel. On deck, the boom tables have been reconstructed and extended into houses supporting steel island-platforms, on which have been placed the winches and the booms correspondingly elevated. These houses also serve to house the winch resistors, and are used as extra electric storerooms and workshop.

The deck machinery is Westinghouse electric drive throughout. The steering-gear is new, being of the American Engineering Co's. electric-hydraulic design. The hand steering and telemotor have been retained, but relocated to suit the new arrangement. The windlass was changed over to motor drive by stripping it of cylinders, connecting-rods, etc., and fitting an extension to the bedplate, on which is mounted additional gearing for coupling to a 45 h.p. motor. Conversion of the capstan was taken care of by turning it through ninety degrees and driving the worm shaft by means of a single spur reduction-gear, the motor being of the same size as the winch motors.

Shipowners who retained the old steam winches for first-cost reduction purposes when making a conversion, have regretted what has in many cases proved to be false economy. This was even found the case by the British when they converted three sister Danish steamers to Diesel power ten years ago. On the *Seekonk* the winches are entirely new and designed and built by the Cramp Company, based on experience gained with winches on the motorships *William Penn, Californian,* and *Missourian.* They are compound geared with gearing entirely enclosed and contained within the gear housing, and running in oil. The motors are 20 h.p. rated capacity, instead of 30 h.p. as used on the former motorships, and capable of lifting 1½ tons on first gear, and 3 tons on second gear. Experience gained shows that the larger size winch, capable of lifting up to 5 tons, is unnecessary, as many stevedores will not handle over 3 tons on a single line.

Two separate kilowatt-hour meters have been located on the switchboard. One of these exclusively registers the current consumed for the cargo-handling winches and the other records the current used by all the ship's above and below-deck auxiliaries and appliances. These meters are carefully read at the start and finish of each day's work and a close check is made at the same time of the oil in the



This sectional profile drawing of the "Seekonk" shows the present underdeck cargo capacity.

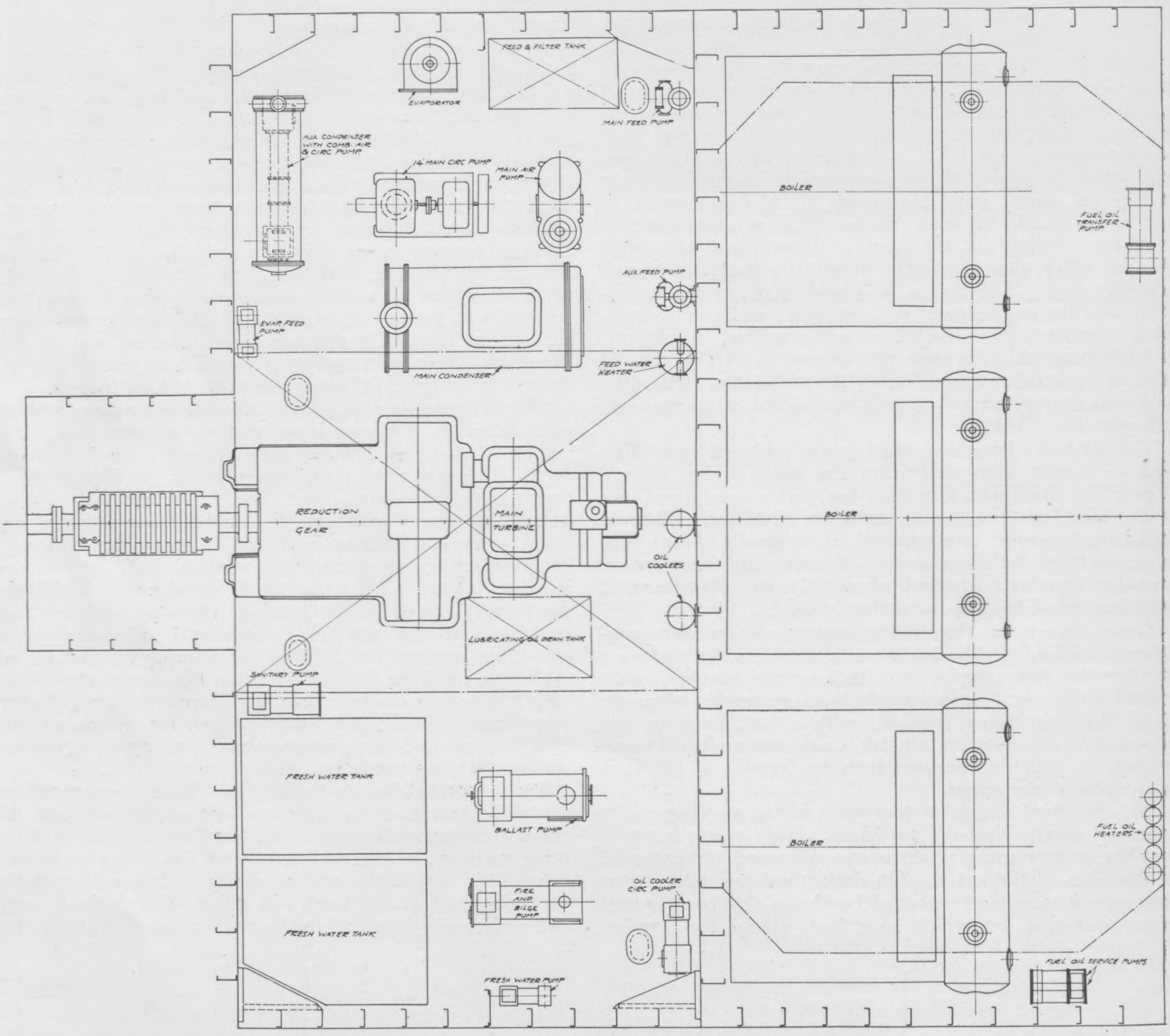
daily service tanks. Figures obtained on the maiden voyage of the *Seekonk* show, a total of 10,445 kilowatt hours consumed by the above and below-deck auxiliaries covering a period of 83 days and 18 hours with a fuel consumption of 55 barrels of fuel.

Electric auxiliaries consumed 5,470 kilowatt hours for handling 9,489 tons of varied classes of cargo at a cost of 0.003046 dollar per ton or slightly over three-tenths of a cent. Prior to her conversion it had been estimated that the electrification of the deck auxiliaries would result in a saving of over $15,000 per year as compared with steam machinery and the present record made by the *Seekonk* indicates that the estimate was a conservative one.

Since that estimate was made the price of both boiler and Diesel oils have increased by about 40%, so that the actual saving over oil-fired steam deck machinery is considerably higher, and will show greater gains for a motorship of this type in cases where the owners have no low-price fuel contract, should there be any further fuel price increase. The steel island platform for the winches was specially constructed at the suggestion of J. D. Tomlinson, general manager of the American-Hawaiian Steamship Co., and this arrangement has proven exceedingly efficient, and could be followed with advantage in the case of other conversions. In one instance it added to the actual earning power of the ship aside from speeding up cargo handling, because a million feet of lumber was piled 10 feet deep on the deck without interfering with the operation of the winches.

Down in the engine-room and on the starboard side the three auxiliary Diesel engines in addition to driving generators, each also drives a specially large three-stage air-compressor which, by means of a change-over valve control, can be made to furnish necessary main engine maneuvering air, thus dispensing with the usual motor-driven maneuvering-air compressor. These compressors can also supply injection-air to the main engine, should its compressor for any reason be out of commission. On the starboard side, also, are two combined motor-driven cooling and lubricating pumps, one of which is a standby; also the donkey-boiler for heating purposes, reserve steam compressor and oil-transfer fuel pump. On the port side are two motor-driven plunger pumps for bilge and sanitary purposes, a rotary ballast-pump and fresh-water pump, the two fresh-water tanks and the maneuvering-air reservoirs. The ice machine, located outside the engine-room, was changed to electric from a steam engine, a feasible and not too expensive job.

Now comes the important question of what benefits have accrued from all these mechanical changes, and, are the gains effected sufficient to more than carry the overhead incurred



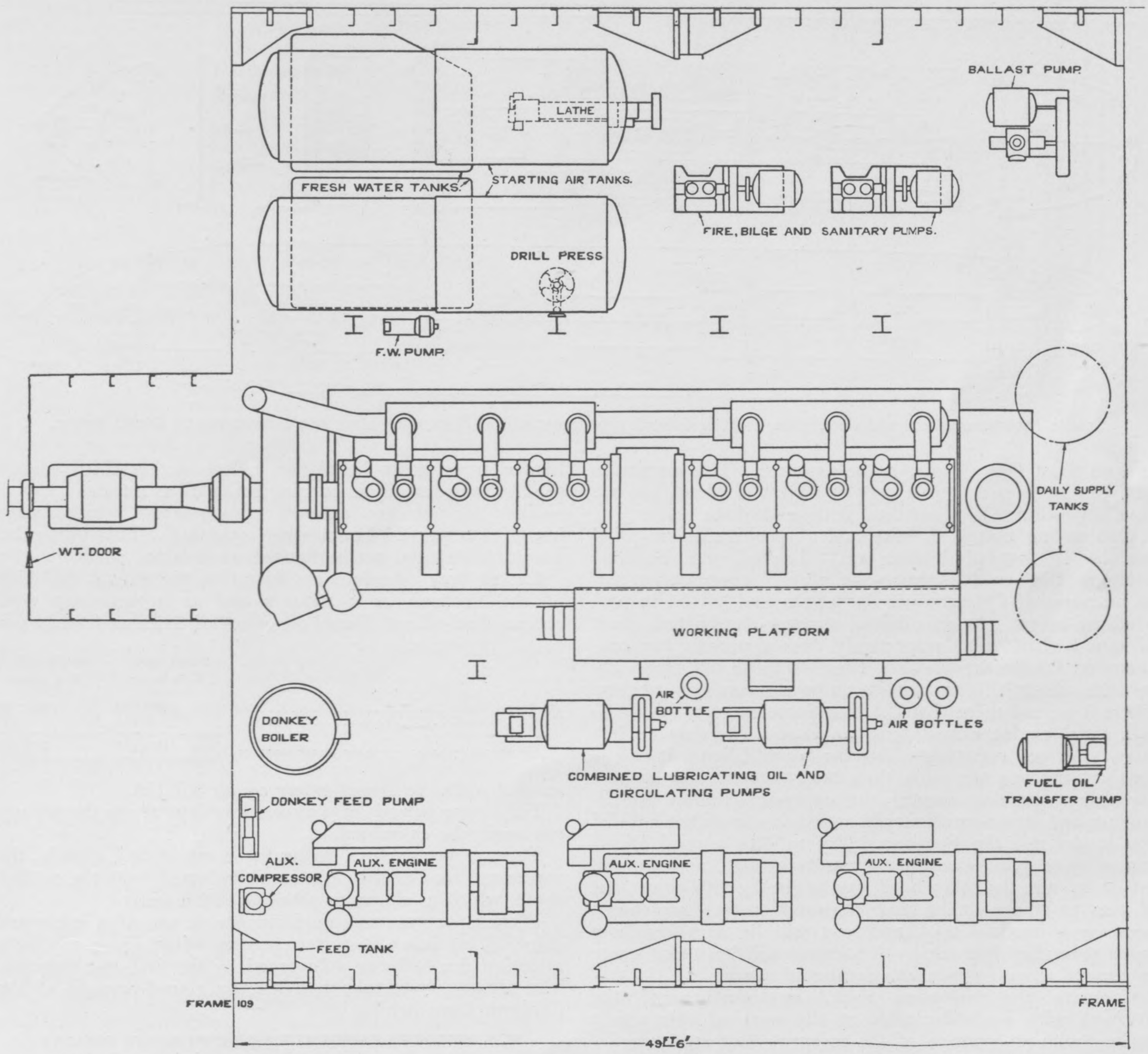
Engine-room of the "Seekonk" prior to her conversion to Diesel power, showing the reduction — geared turbines and boilers.

by the cost of the said changes. To duplicate the *Seekonk* today incorporating a number of minor modifications based on the experiences with her in service would cost approximately \$500,000 and would vary a little with the individual hulls. The hull would cost about \$100,000, making a total of about \$600,000 or \$1.47 per cubic-foot (grain) of cargo space, for the ship delivered ready for service to the owner, of which we presume \$300,000 could be borrowed from the Shipping Board at 4¼% interest. Assuming that the balance of the money is secured at 5½% the annual charge on the first cost works out at \$29,250. A steamer of 7,754 d.w. tons purchased at \$30 per ton will have an annual charge on the investment at 5½% of \$12,794. This gives us a difference of \$16,456 per year to be met, and which we balance-off towards the end of this article following our discussion of the extra cargo earnings, wage savings, and fuel economies. In the aforementioned hull price we have quoted \$10 per ton as we understand that the valuations of the Hog Island boats are a little higher than other classes, although the *Seekonk* cost about \$8 per ton. Consequently in our comparison figures we are favoring the steamer to an almost undue extent.

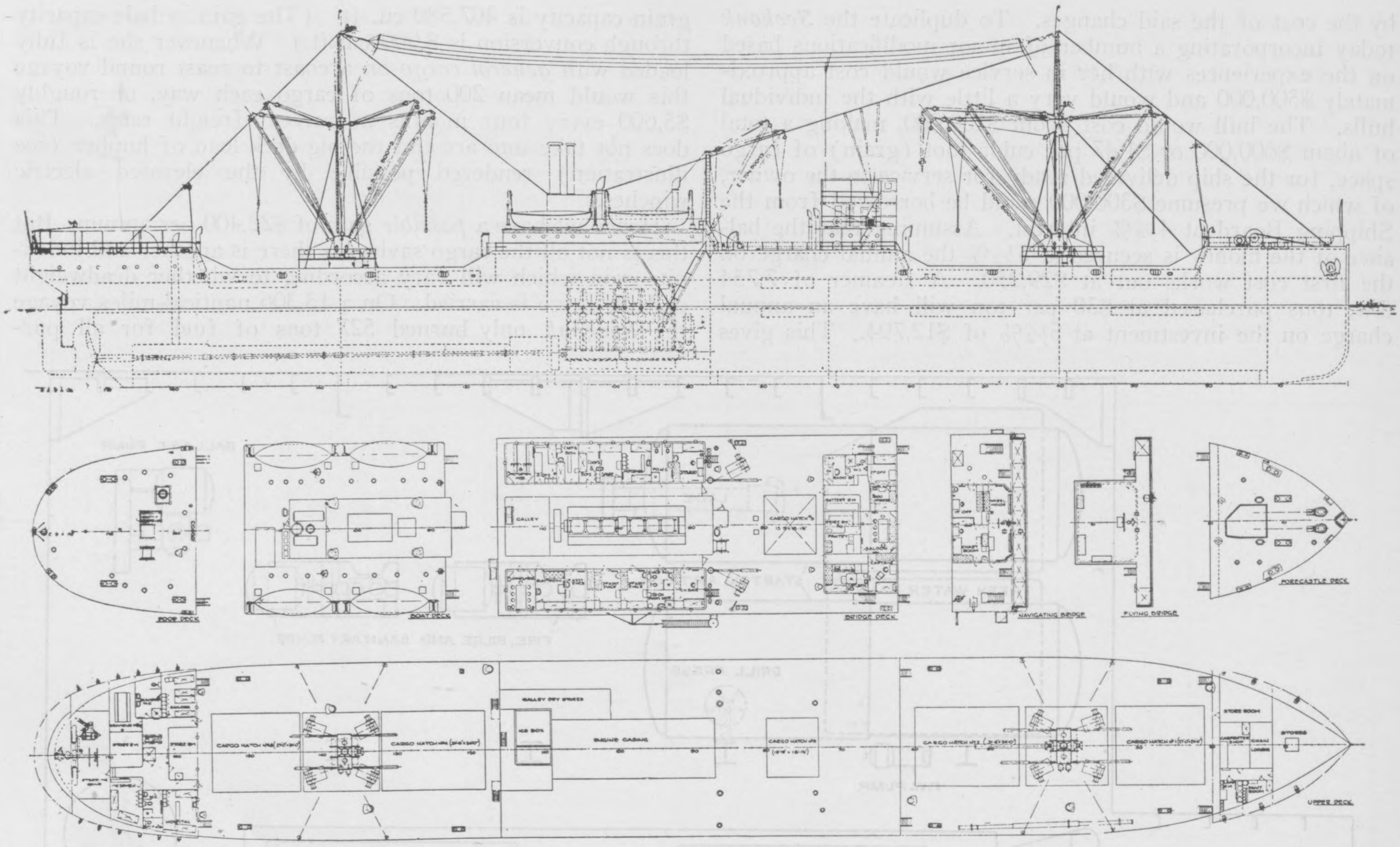
Her total bale capacity now is 382,210 cu. ft. and the grain capacity is 407,580 cu. ft. (The gain in bale capacity through conversion is 8,990 cu. ft.) Whenever she is fully loaded with *general cargo* on a coast to coast round voyage this would mean 200 tons of cargo each way, or roughly \$5,600 every four months at current freight rates. This does not take into account the big deck load of lumber (see illustration) rendered possible by the elevated electric winches.

Hence we have a *possible* gain of \$22,400 per annum. But this is not all the cargo saving as there is another and indefinite gain which will vary according to whether deadweight or bulk cargo is carried. On a 13,306 nautical-miles voyage the *Seekonk* only burned 527 tons of fuel for all purposes including 54 days in port. This means that she can carry about 800 tons greater deadweight cargo than as a steamer, or a possible larger earning power from this source of \$22,400 per round voyage or \$89,600 per annum. For this she must be fully loaded out and return.

Should bulk cargo be carried on a transatlantic voyage, it is possible to fill her bunkers with 1,100 tons of fuel-oil and sell as cargo at least 700 tons at a profit over its cost of at least \$5,000. Because these things cannot easily be determined ahead of time, and as they may vary every voy-



Engine-room plan of the motorship "Seekonk" after her conversion to Diesel power.



Profile accommodation and deck plan of Hog Island type motorship "Seekonk" after her conversion to Diesel power.

age, no fixed figure can even be assumed. This particular gain can be regarded as a sort of "extra dividend," so we have not included it in our total at the end of the article.

One saving that is definite and as positive as anything can be is that of bunker oil. Loaded, the *Seekonk* averages 10¼ to 10½ knots on a daily consumption for all purposes of 7½ tons per day at sea and ⅓ ton in port handling cargo. As an oil-fired steamer she burned about 27 tons and 6½ tons respectively. As a steamer her consumption fluctuates; but as a Diesel ship do not make any mistake about the maximum daily consumption at sea. There it is; not more than 7.5 tons for evermore. A properly rated engine cannot burn an excess. It may be less later. For our comparison purpose we will figure it as 7½ tons or just one ton more than *the steamer burns in port* each day. In this respect the contrast between Diesel-engines and steam-machinery is as fixed as were the laws of the Medes and the Persians. Try to give a good Diesel engine more than her regular quantity of fuel, and she will refuse it. On the other hand, try to get the full power out of your turbine with the same consumption that was shown once on a contract trial, and you will be surprised how much more fuel is needed. A steamer will burn and waste oil beyond any oil producer's dreams of avarice.

Compare the following actual performance of the *Seekonk* with a similar table at the start of this article dealing with an average of the seventy sister steamers.

PERFORMANCE OF SEEKONK AFTER CONVERSION

Sea speed (loaded)	10.5 knots
Daily fuel consumption at sea	7½ tons
Daily fuel consumption in port	⅓ ton
Daily fuel cost at sea	$110.25
Daily fuel cost in port	$4.83

Actually the *Seekonk* has been paying $1 per barrel under contract for her fuel; but for the purpose of this article and to be conservative we are assuming that she is burning Diesel oil at the price of $2.10 per barrel now current, and have ignored the lower price that her owners have recently been paying. By assuming a lower grade of fuel our figures would show to even better advantage, but overhaul charges might be higher. Now on her third voyage the *Seekonk* actually is burning boiler oil as a test.

The *Seekonk* has a small donkey-boiler which burns but ¼ ton per 24 hours when operated. This particular consumption need not be figured, as it is too small.

Let us now take into consideration the annual fuel-bills of the *Seekonk as a steamer and as a motorship* with current fuel-oil and Diesel oil prices of $1.75 and $2.10 per barrel respectively.

	SEEKONK (With Steam Power)	SEEKONK (With Diesel Power)
240 days at sea	$85,260	$26,460
125 days at port	9,952	604
Total	$95,212	$28,064

Annual saving to Diesel power equals $67,158.

For longer periods in port and less days at sea the savings can easily be calculated.

There is yet another saving to be considered, namely, the wages and food of the eight men eliminated from the engine-room, which as shown is about $8,600 a year.

What is the average performance at sea of a converted ship? This is an important matter often given too little attention due to being submerged by the first-cost question. The answer is to take two lengthy round-voyages of the *Seekonk* from her log.

M. S. SEEKONK'S PERFORMANCE ON TWO ROUND VOYAGES

(Actual figures from United American Line's Records)

	Maiden Voyage 1	Second Voyage 2
Voyage duration	108 days	104 days
Time at sea	53.214 days	52.206 days
Time in port*	54.786 days	51.794 days
Distance	13,306 naut. miles	12,819 naut. miles
Mean speed	10.42 knots	10.23 knots
Propeller slip	8.63 per cent	7.86 per cent
Mean draft	17′–5½″	21′–6″
Displacement in sea water	7,620 long tons	9,620 long tons
Power of main engine	2,250 i.h.p.	2,200 i.h.p.
Power of auxiliary engine	100 i.h.p.	100 i.h.p.
Total power	2,350 i.h.p.	2,300 i.h.p.
Total fuel-consumption at sea	2,967 barrels or 417 tons	2,791 barrels or 392 tons
Fuel-consumption per day at sea	55.8 barrels or 7.84 tons	53.4 barrels or 7.50 tons
Total port* fuel-consumption	768 barrels or 108 tons	454 barrels or 64 tons

	Maiden Voyage 1	Second Voyage 2
Fuel-consumption per day in port	14.0 barrels or 1.97 tons	8.77 barrels or 0.73 tons
Total fuel consumed for all purposes at sea and in port	3,735 barrels or 525 tons	3,245 barrels or 456 tons
Distance per ton of fuel	31.9 naut. miles	32.7 naut. miles
Season and weather	Winter — quarters steam heated Normal inter-coastal winter weather.	Spring. 3 day head weather moderate.

* —*Note.* This includes river and harbor steaming of about 1,000 miles.

At the end of the first voyage fuel-oil to the extent of about 94 bbls. was left in Number 2 tank. This oil had become mixed with salt water so was pumped overboard. Apparently this quantity was included in the owner's registered consumption, and the donkey-boiler was used for about three weeks after arriving in New York, and partly accounted for the 108 tons of fuel used in port between then and leaving Baltimore on the second voyage. So in reality the fuel-consumption per i.h.p. hour was below 0.30 pound.

MAIDEN VOYAGE

Lubricating oil consumption

	In port	*At sea*
For general lubrication	26	120 gals.
For cylinder lubrication	6	245 gals.
For compressor lubrication	40	75 gals.
Total	72	440 gals.
Average per day	2.51	7.86 gals

Fuel-Consumption of Auxiliaries on Maiden Voyage Analyzed

	Tons per day
Donkey-boiler when in operation	0.41 ton
One auxiliary in port, when not handling cargo	0.27 ton
When Handling Cargo —	
Two auxiliary engines in operation from 8 a.m. to 5 p.m. and one auxiliary engine in operation remaining time	0.42 ton

Loading and Discharging Cargo on Maiden Voyage

Total cargo handled	9,489 tons
K.W. hours input to winch motors	5,470 tons
Proportion of total fuel consumption, auxiliary engines, for K.W. input to winch motors	4.1 tons
K.W. hours per ton of cargo handled	0.576
Pounds of oil per ton of cargo handled	0.97

What is the best that the *Seekonk* can do also may be asked. On one three hours test the following results were obtained:

A THREE HOURS TEST RUN

Fuel-oil .... 0.902 gravity (7.52 lb. per gal.)	
Mean engine speed	90.9 r. p. m.
Power, main engines	2,410 i. h. p.
Power, aux. engine	100 i. h. p.
Total power, machinery	2,510 i. h. p.
Fuel-consumption, per hour	98.8 gals. (abt. 2⅓ bbls.)
Fuel-consumption, per hour	705 lbs.
Fuel-consumption per i. h. p. hour, referred to main engine	0.292 lb.
Fuel-consumption per i. h. p. hour, referred to all engines	0.281 lb.

In good weather the best three days run on one voyage was as follows:

BEST THREE DAYS RUN

Speed by observation	10.66 knots
Propeller speed	86.1 r. p. m.
Slip	5.3 per cent
Fuel per 24 hrs. *main and aux. engines*	7.43 tons
M. i. p. main engine	89.0 lbs/sq. in.
M. i. p. aux. engines	70.7 lbs/sq. in.
Power main engines	2,285 i. h. p.
Power aux. engines	120 i. h. p.
Power main and aux. engines combined	2,405 i. h. p.
Fuel oil per i. h. p.-hr. *main engine only*	0.303 lb.
Fuel oil per i. p. h.-hr. *main and aux. engines*	0.288 lb.

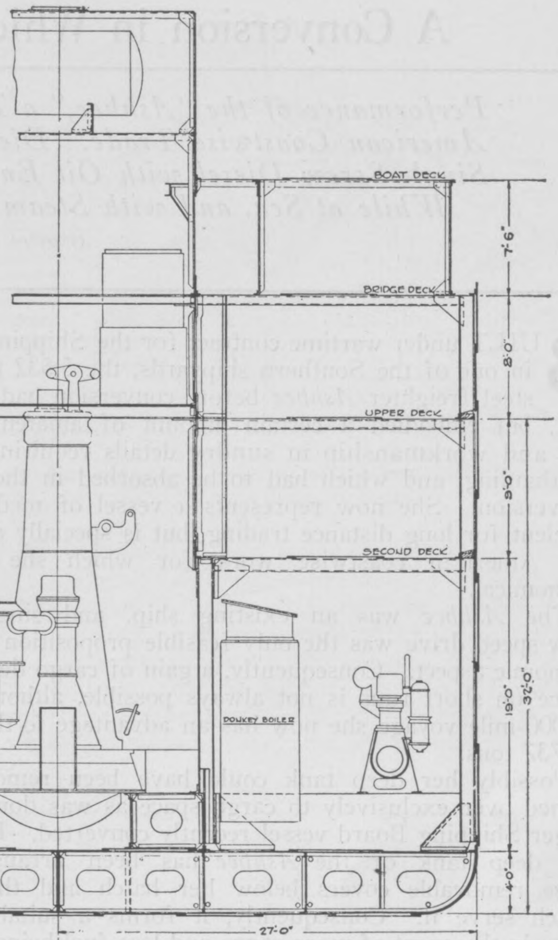
As we write the *Seekonk* is on her third voyage and has covered two legs of 1,960 and 2,913 miles respectively. The main engine's mean powers were 2,031 and 2,237 i.h.p. at 81 and 83 per minute, and the ship's speed 10.26 and 10.5 knots on daily consumptions of 6.58 and 7.16 tons oil respectively. The drafts were 16′ 8″ and 16′ 5″. These consumptions included that of one of the 100 b.h.p. auxiliary engines.

We can now sum up the various economies effected and the maximum possible additional earnings annually under today's conditions as the results of conversion, as follows:

BALANCE SHEET

Hog Island Type A Converted Ship's Economies Over Steam

Extra Earning Capacity (if bulk cargo)	$27,400
Extra Earning Capacity (if deadweight)	$89,600
Wages and food of crew eliminated	8,600
Fuel saved (if 240 days at sea and 125 days in port)	67,158
Total	$165,358 per annum.



Section of the motorship "Seekonk" in way of machinery space showing engine beds, donkey boiler, auxiliary Diesel engine, etc.

Capital charges on converted steamer of *Seekonk* type	$29,250
Capital charges at 5½ per cent on non-converted steamship bought from Board at $30 per d.w. ton	12,794
Debit Diesel power	$16,456
Operating economies of *Seekonk* type motorship	$165,358
Less Higher Capital Charges of	16,456
Balance in favor of Diesel Drive	$148,902

As will be noted from the first line of the balance sheet the cargo earnings of the motorship will be about $60,000 per year less if light bulk cargo is carried, and if there are no earnings from surplus fuel-oil carried as cargo.

If a converted vessel burns boiler-oil the saving today will be nearly $2,000 per annum greater. This raises the question—is it worth while to burn the lower grade oil under present conditions? Whatever the answer may be, every converted ship should be equipped with oil-heaters and centrifugai purifiers in order to be in the position to be able to meet changed fuel conditions and be capable of bunkering and burning any grade of oil available.

Let us also remember that altho we have based our comparisons assuming that the steamer uses oil at $1.75 per barrel, she sometimes has to buy fuel in Europe and pay $3 per barrel due to her smaller radius.

It is noteworthy that the *Seekonk's* lubricating-oil consumption of under 8 gallons per day at sea is only slightly higher than with a steam plant. Her lubricating oils also pass through a centrifugal device.

By the installation of an electric-driven supercharger at an additional cost of about $1,500 the power of the engine would be increased by approximately 350 horsepower, and give the ship nearly half-a-knot better speed.

Lastly, what maintenance charges shall be set against these economies may be asked. If we take recent American motorships such as the *William Penn, Californian, Missourian, H. T. Harper, Seekonk* and *Challenger* the answer is—lower upkeep charges than with a steamer!

A Conversion in Which Steam-Winches Were Retained

Performance of the "Ashbee," a Type of Cargo Ship Particularly Adaptable for the American Coastwise Trade. Diesel Power is Used for Propulsion in the Form of Single-Screw Diesel with Oil Engine-Electric Machinery for Auxiliary Purposes While at Sea, and with Steam Drive Retained for Deck Machinery in Port.

(Verified by the New York Shipbuilding Corpn.)

BUILT under wartime contract for the Shipping Board, in one of the Southern shipyards, the 5,532 tons d.w. steel freighter *Ashbee* before conversion had a sound hull, but embodied a certain amount of amateurish layout and workmanship in sundry details requiring proper overhauling, and which had to be absorbed in the cost of conversion. She now represents a vessel of medium size efficient for long distance trading, but is specially adaptable for American coastwise work for which she is very economical.

The *Ashbee* was an existing ship, and single-screw, slow-speed drive was the only feasible proposition from an economic aspect. Consequently, a gain of cargo deadweight space on short runs is not always possible, although on a 10,000-mile voyage she now has an advantage to the extent of 737 tons.

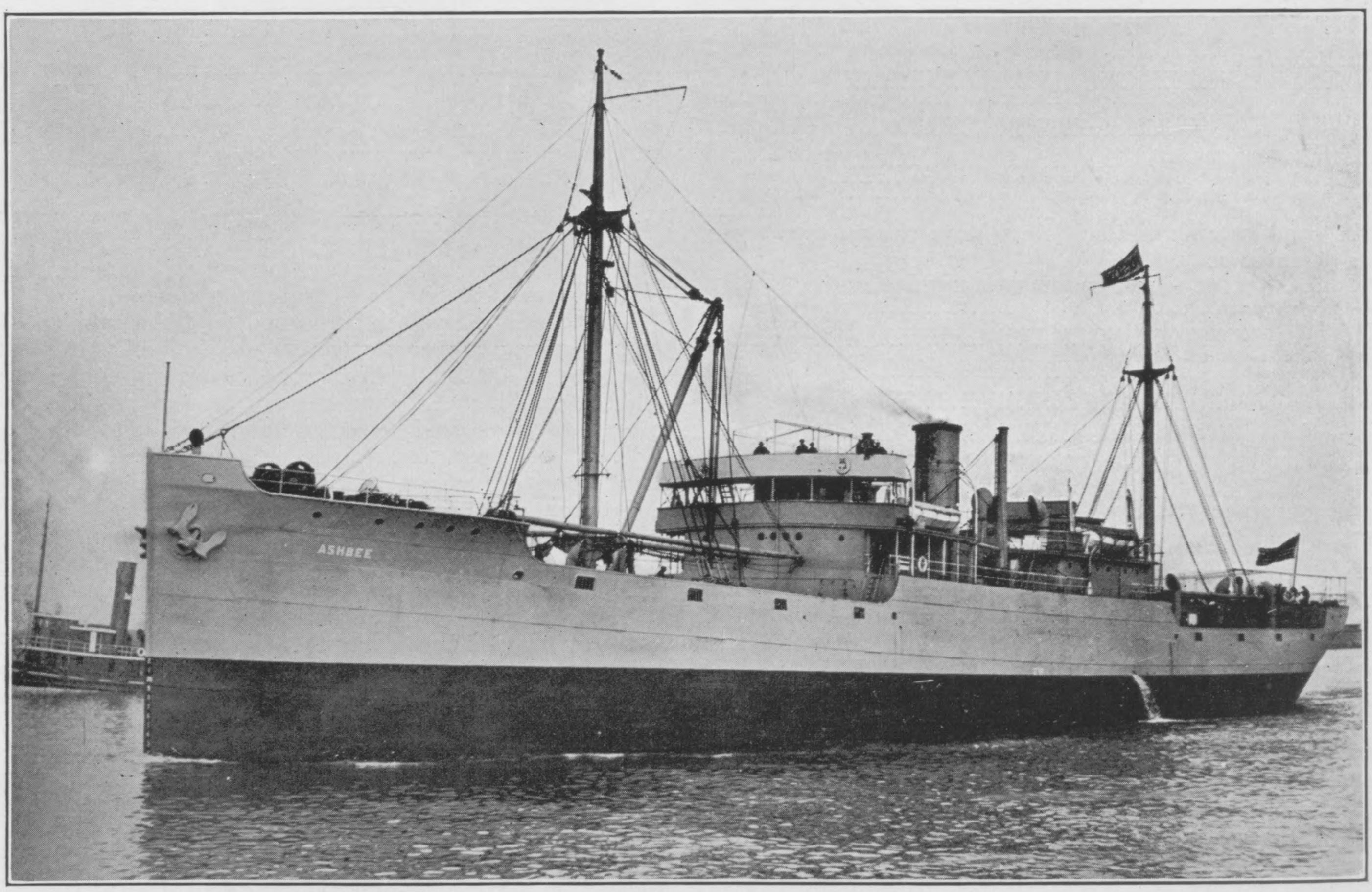
Possibly her deep tank could have been removed and turned over exclusively to cargo space as was done with a larger Shipping Board vessel recently converted. However, the deep tank of the *Ashbee* has been arranged with large removable covers below her hatch and the booms which serve it. Consequently, it forms a suitable cargo space in the event of more cargo and less fuel being a desirable condition whenever the ship is in coastwise trade or in some other short haul service. Unless extra cargo space is needed it is preferable to carry a portion of the fuel in the deep tank.

Conversion of the *Ashbee* was carried out ahead of similar work on the sister steamer *Jacksonville* nearing completion at the yard of the New York Shipbuilding Corporation, Camden, N. J., who purchased both hulls, built the main Diesel engines, and who now own the resultant motorships, the first of which is operated for them by W. R. Grace & Co., of New York, N. Y. The success of her maiden voyage to South America as outlined in this article should be an added incentive for American shipping companies to follow this example whenever this class of vessel meets their particular requirements.

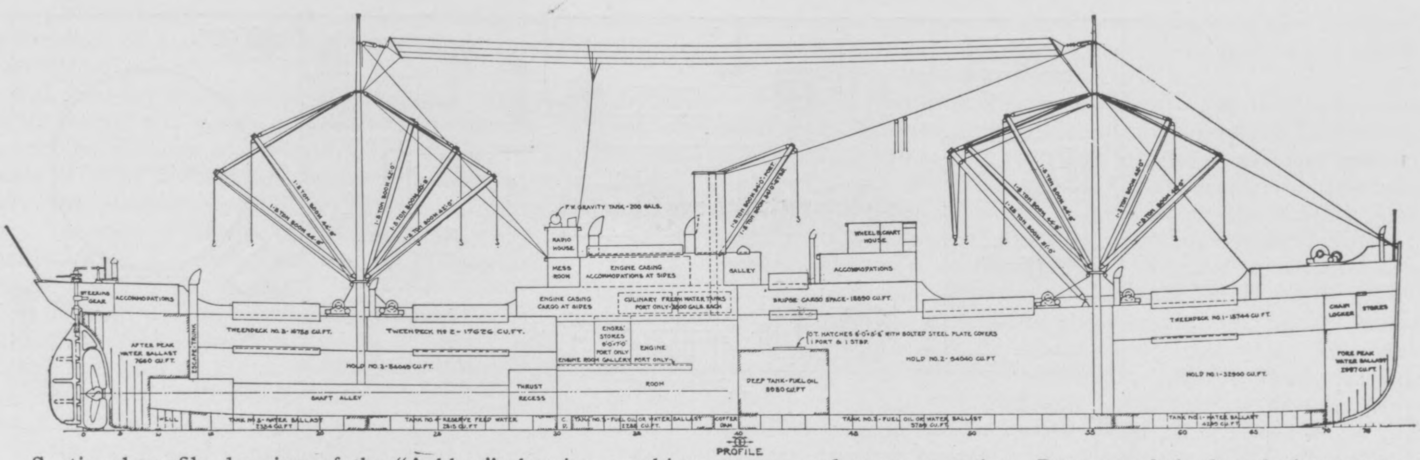
We do not propose to discuss her six-cylinder, 27″ x 47″, four-cycle, single-acting Diesel-type propelling engine as full details of its design can be found in MOTORSHIP of April, 1923. The following are the main dimensions of the vessel.

Dimensions of the Ashbee.

Loaded displacement	8,125 tons.
Light displacement	2,593 tons.
Weight of Diesel and aux'l. mach'y	460 tons.
Weight of main engine only	263 tons.
Length overall	346′ 6″
Length B. P.	346′ 6″
Depth to upper deck	27′ 6″
Breadth moulded	48′
Draft loaded	22′ 5½″



The motorship "Ashbee" after her conversion to Diesel power. Electrical auxiliaries have been installed in the engine-room, but the steam winches were retained on deck. By fitting a hydro-electric steering gear reasonable economy has been secured, due to the fact that the new donkey-boiler is only used when in port. Her single propeller turns at 105 r.p.m.



Sectional profile drawing of the "Ashbee" showing machinery space and cargo capacity. Because of the low fuel-consumption with Diesel power it is possible to utilize the deep-tank space for cargo on long voyages.

	"Ashbee" as a Steamship.	"Ashbee" as a Motorship.
Deadweight capacity (tons)	5,740	5,532
Bale capacity (cu. ft.)	257,933	250,004
Gross tonnage	3,532	3,434
Net tonnage	2,151	2,147
Fuel-oil capacity (tons)	1,179	868
Reserve feed-water (tons)	221	157
Shaft horsepower	2,000	1,500
Indicated horsepower	....	2,000
R. P. M. of propeller	90	110
Service speed (knots)	10.5	10
Daily fuel-consumption (tons)	24.6	7.11
Corresponding radius (naut. miles)	12,000	28,800

Increased cargo-carrying capacity after conversion due to decrease in weight of fuel and water required for motorship on voyage of 10,000 mile radius—737 tons. She now has 500 i.h.p. less power at 20 r.p.m. higher, yet her average speed on the maiden voyage was 10.23 knots, or about the same as before. Maintenance of an even propeller speed largely accounts for this.

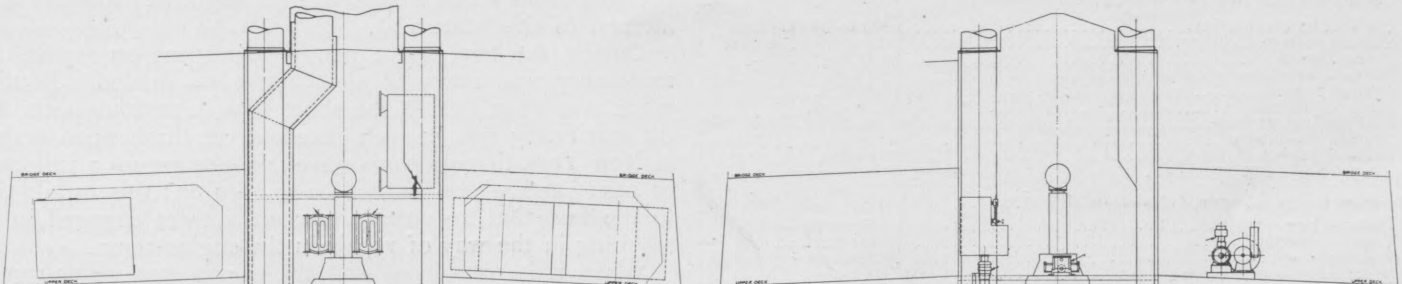
We are authorized by the New York Shipbuilding Corporation to publish the facts concerning the performance of the *Ashbee* on her first commercial run with her new machinery. This voyage was from New York to the West Coast of South America, the total distance covered being 8,740 nautical miles, and included two non-stop runs of 1,823 and 1,780 nautical miles from New York to Cartagena and Puerto Colombia to New York, respectively. The balance of the trip was short runs from port to port, but which served thoroughly to test the maneuvering qualities.

So many direct comparisons have been made between the economy of motor-vessels and steamships that it seems no longer necessary to go into exhaustive detail in making comparisons. It should suffice to state that the *Ashbee* is one of the most economical motor-vessels afloat today, notwithstanding the fact that she has steam winches.

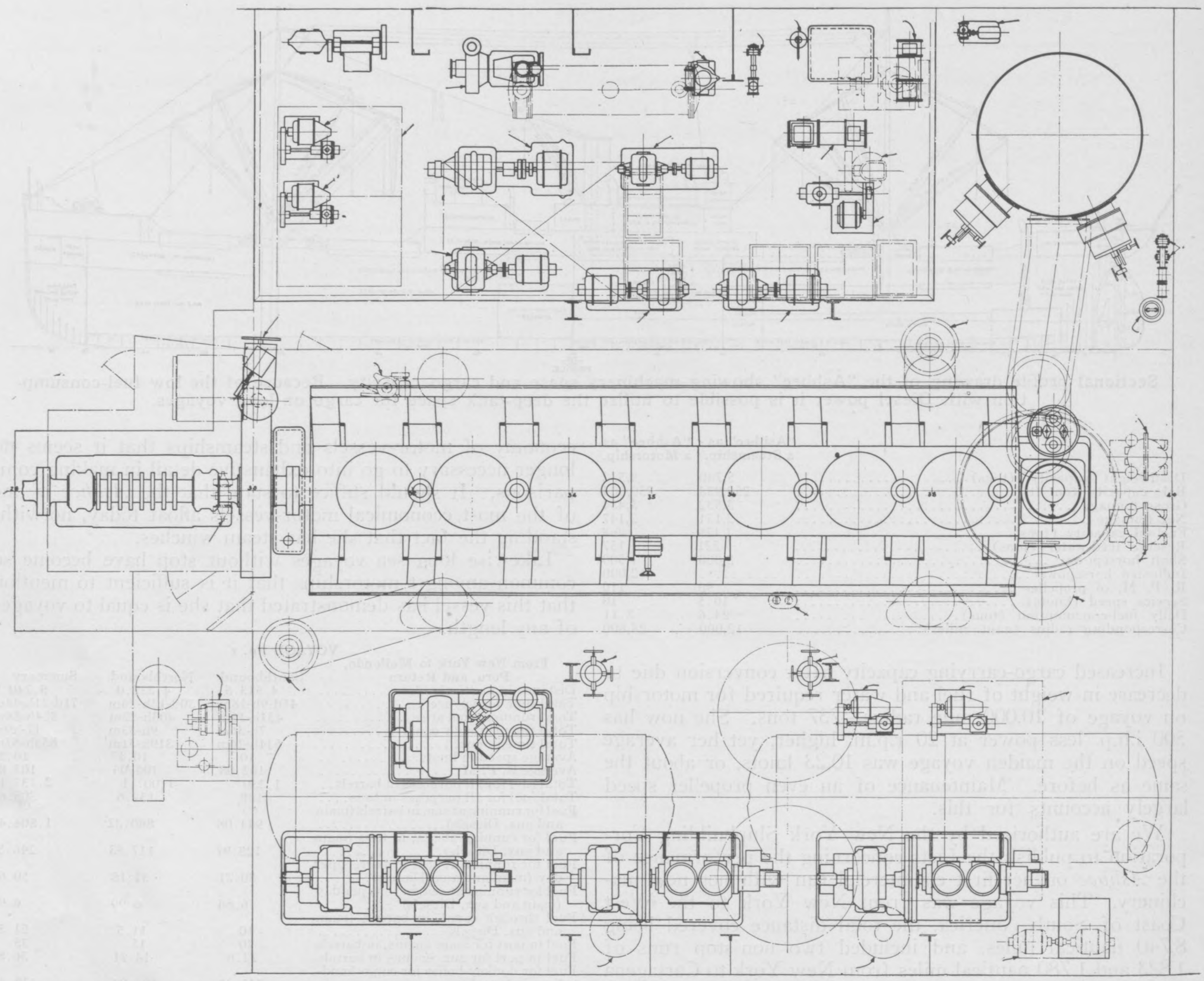
Likewise long sea voyages without stop have become so common amongst motorships that it is sufficient to mention that this vessel has demonstrated that she is equal to voyages of any length.

VOYAGE No. 1

From New York to Mollendo, Peru, and Return	Southbound	Northbound	Summary
Distance in nautical miles	4,513.5	4,227.0	8,740.5
Total time for voyage	41d-9h-18m	30d-12h-26m	71d-21h-44m
Total running time at sea	451h-16m	403h-22m	854h-38m
Total time through canal	7h-36m	9h-33m	17-h9m
Total time in port	534h-26m	319h-31m	853h-57m
Average speed in knots	10	10.47	10.23
Average R. P. M	102.08	104.06	103.07
Total fuel for all purposes in barrels	1,230	1,007.1	2,237.1
Total fuel for all purposes in tons	168	137.6	305.6
Fuel for running at sea, in barrels (main and aux. Diesels)	944.08	860.32	1,804.4
Fuel for running at sea, in tons (main and aux. Diesels)	128.97	117.53	246.5
Fuel for running at sea, in barrels per day (main and aux. Diesels)	50.21	51.18	50.69
Fuel for running at sea, in tons per day (main and aux. Diesels)	6.86	6.99	6.92
Fuel through canal, in barrels (main and aux. Diesels)	10	11.5	21.5
Fuel in port for main engine, in barrels	20	15	35
Fuel in port for aux. engine, in barrels	22.6	14.21	36.81
Fuel for donkey-boiler for cargo handling, in barrels	233.32	106.07	339.39
Fuel for donkey-boiler for cargo handling, in tons	31.87	14.49	46.36
Miles per ton of fuel	35	35.96	35.45
Cargo handled in port, in tons	6,913	2,966.9	9,879.9
Cargo in tons per ton of fuel	216.91	204.75	213.1
Number of ports of call	16	11	27



Cross-sections of engine-room of motorship "Ashbee" following conversion.



Engine-room of the "Ashbee" after conversion showing arrangement of the New York-Werkspoor main engine, the Worthington auxiliary oil-engines, electric auxiliaries and the donkey-boiler.

SUMMARY OF TWO NON-STOP RUNS ON MAIDEN VOYAGE

Non-stop run from New York to Cartagena, Colombia:

Distance by observation	1,823 nautical miles
Time in passage	7 days 10 hrs. 58 min.
Average speed	10.18 knots
Average fuel-consumption per day	7.17 tons
Average power	2,003 i.h.p.
Mean engine speed	100.9 r.p.m.
Fuel per I. H. P. hour	0.305 lb.
Average mean draft	17′ 5″
Distance per ton of fuel	34.1 miles

Non-stop run from Puerto, Colombia, to New York:

Distance by observation	1,780 nautical miles
Time in passage	7 days 4 hrs. 38 min.
Average speed	10.31 knots
Average fuel-consumption per day	7.02 tons
Average power	1,990 i.h.p.
Mean engine speed	102.3 r.p.m.
Fuel per I. H. P. hour	0.301 lb.
Average mean draft	16′ 5″
Distance per ton of fuel	35 miles

Yet the most interesting part of her performance lies in the numerous stops in ports of call. To give a comprehensive idea of what these amounted to on this trip, reference to the engineer's "bell book" is necessary.

By consulting this little book it is learned that the engine responded to 1,109 signals from the bridge which does not include 81 "stand bys" and 44 times that "finished with engines" were also registered by the telegraph. One example of a remarkable maneuvering is where the vessel docked at Buenaventura, Colombia, and the engine responded 57 times in exactly as many minutes without starting an auxiliary compressor. The fact that she is a single-screw ship, and that the auxiliary oil-engines are not equipped with compressors from which a supply of air might be "robbed" adds interest to this statement.

During the trip, not a penny was spent on repair, the machinery was ready at all times when needed. Routine work was done during the short lays in various ports and the machinery was in such excellent condition upon arrival in New York that no pains were taken to get on a full crew of oilers and wipers until time to sign on; this in addition to the fact that no outside mechanics were engaged to do anything in the way of repair in the engine-room.

When it is considered that the engine was never run in the shop prior to its installation in the hull, it is remarkable to note that this first engine and first Diesel installation of this Company has turned around and sailed again in the same condition in which it arrived from the maiden voyage, with the exception of the additional installation of about 10 feet of 2½ inch pipe in the cooling water service and a slight change in the shape of the orifices in the piston cooling jets. The engine's rated power of 2,000 i.h.p. was exceeded as an average for the trip.

The owners, however, were not taking a cock-sure attitude and were as careful to make a survey of the machinery as if they were the worst possible form of skeptic. This, to insure themselves that not a thing was being overlooked.

Two pistons were removed and a survey of the cylinders made while the condition of the rings was also noted. The only word that can express the condition found is, excellent.

The pistons were put back in the cylinder with only the application of a little extra cylinder oil to insure a smooth start.

The unusual accessibility of the engine was demonstrated most clearly, for piston removal only occupied the time of three men for two-and-a-half hours while replacement was made in three hours with the same number of men. However, the pistons were left out of the cylinders for several days to show visitors—of which there were many—how easily the job could be done without setting tackles and only using a few light wrenches.

In recounting the experience of interest and importance gained on the voyage which the *Ashbee* has just completed, it is well on the start to call attention to the fact that this vessel was not built for the trade in which she has been placed.

While motorships have made excellent records on voyages where continuous operation for days on end have caused the shipping world to admire their state of mechanical and economic perfection, it is doubtful whether any of them have made a better trip than *Ashbee* has completed, demonstrating the adaptability of Diesel power to the coastwise trading service which America is very anxious to more firmly establish herself in. In entering this service it has been necessary for this vessel to compete with other small ships built especially for service wherein large vessels with heavy capital investments cannot exist unless a remarkable saving in cost of operation exists.

In sending out the *Ashbee* the principal object was to demonstrate the absolute dependability of the machinery which is 100% American product, except for piston rings, the main engine being an Americanization of the well-known Holland Werkspoor type, and produced by the New York Shipbuilding Corp., of Camden, N. J., designed to develop 2,000 i.h.p. at 110 r.p.m., while the auxiliary machinery is principally Worthington and General Electric, there being also Blackmer pumps, Row and Davis re-circulating system and heaters and exhaust-gas fired steam generator, Ligerwood winches and the Hyde Windlass Co. represented in stearing gear. In addition to these there are several other well-known manufacturers represented in valves, castings, electrical equipment and various small devices of importance.

The maiden voyage was ideal in one respect for while the total distance covered, exclusive of harbor and canal distance, was 8,740 miles, yet stops were made at 16 ports while outward bound and 11 while homeward bound, but the first and last ends of the voyage—from New York to Cartagena, Colombia, and home from Puerto, Colombia, to New York were distances of sufficient length to give a thorough demonstration of the dependability of the propelling machinery in long continuous sea passages.

Perhaps the most interesting results occurred in connection with the operation of the steam deck-machinery which, being a conversion job, was allowed to remain in the ship.

Perhaps if the owners had known the trade the vessel would enter they would never have put in the donkey-boiler and would have equipped her with electrical deck-machinery. They did not know what the ship would do. They thought that a ship such as she would go in long haul service where the proportionate time the boiler would be carrying steam would be very small. Calling at so many ports has not given the steam deck-machinery a fair show, yet an economy is apparent from one angle. By stating that the steam deck-machinery has not been given a fair show we really admit that electrical deck-machinery is superior in some respects, probably most respects. In fact we are strongly in favor of electric power wherever practical and economical.

However, here is a situation which will arise repeatedly in connection with conversion work, one which is thought of often and one which should be studied by any firm contemplating a conversion, and we desire to be impartial and fair to steam equipment. Therefore, we wish to show just what can be done in the way of utilizing steam winches already installed, and what may be expected as the result of such utilization, when the work is done by a capable firm well versed in the most modern and up-to-date methods of effecting economy with steam boilers.

Advocating an expenditure which will run the capital cost so high as to more than offset the economy of fuel is not a wise procedure. The size of ship, the route, and number of ports of cali all have a factor. Consequently we have been greatly interested in what the owners of the *Ashbee* have said in connection with the use of steam winches. First, it is not a difference of cost between electrical deck-machinery and source of motive power for such machinery, as compared to the cost of steam winches and a small boiler which would be the case where a motorship were built new. The deck machinery was already on the ship and installed. If this machinery were removed and scrapped, its re-sale value would not pay for the work involved. This due to the greater demand for more modern electrical equipment. It is quite apparent that with this ship the conversion to electrical machinery on deck is not a comparative cost but a total amounting to the purchase price plus the cost of installation, assuming that the new steam arrangement in the engine-room about equals in cost the additional power equipment in the form of oil engines and electrical machinery, to drive the winches, in a 100% conversion job.

Forgetting for the time the actual amount of difference, which in itself would be difficult to estimate accurately without experience in conducting both jobs, let us see what the steam has done on the voyage just finished.

Here the loading and discharging was carried out under all conditions of weather. In New York while taking on cargo the snow and sleet was so bad as to cause the discontinuance of work on several occasions. Down in the tropics the heat of the day was almost unbearable. The boiler was designed to carry the full number of winches under all conditions of loading and weather with a safe margin of extra power, and is of the vertical fire-tube type commonly used on steam vessels as a donkey-boiler.

It serves as a source of heat for the quarters while the ship is in port, but is not required at sea as the exhaust-gas steam-generating system has been more than ample in the most severe weather conditions. All engine-room auxiliary power is supplied at sea with Worthington oil engines and General Electric generators, which also take care of the new hydro-electric steering gear and the ice machine.

The fact that the boiler was designed for the work seems to be the secret of its economy, as economy is rated in steam plants. To analyze the trip it is found that the ship was in port 853 hrs. 57 min., and that the boiler was in use 392 hrs.

In port the boiler was in use an average of 10.44 hrs. per day. The total average fuel-consumption while boiler was in use was 0.89 bbl. per hour for all purposes or 9.28 bbls. per day plus auxiliary oil-engine fuel consumption for the remaining 13.56 hours at a rate of 1.99 gals. per hour, making 0.63 bbl. The average total consumption per 24 hours in port was then 9.91 bbls. for all purposes, or 1.35 tons.

It would appear from the foregoing that the great loss in cargo work on a steamship is not primarily due to the fact that the ship discharges cargo with steam power, but that the steam-boiler and a large portion of the auxiliary machinery in the engine-room is entirely out of economic balance with the power requirements for cargo handling. It also appears that a small steam plant on a motorship can be made to operate at about the same fuel consumption ratio as that between a steamship and motorship.

We must, therefore, assume that on conversion jobs where the steam deck machinery has been so very uneconomical that it has been largely due to the fact that an old boiler, too large for the work or some similar unbalanced condition has caused the losses. It is a well known fact that steam power is generated in the ordinary way at three to four times the cost of oil-engine power.

The *Ashbee's* use of steam is limited to cargo discharging, mooring and anchoring the ship, which in some trades

would amount to a very small amount in actual time. Her last voyage was an exceptionally broken-up affair with calls at ports along the South American coast almost daily and sometimes at two ports in a day, yet her boiler was under steam only 24% of the total time she was on the voyage.

If her boiler were in use 100% of the time, as it would be if the steering-gear and all the rest of the auxiliary machinery were steam driven, then the situation would be entirely different and it would be impossible to make a comparison between her performance and a 100% conversion, having in mind economy from a capital cost point of view, in place of laying emphasis on fuel economy. After leaving New York the ship spent 50% of her time in port. Only 45% of that port time was spent in actual work of loading and discharging, lifting hatches and replacing them, hauling ship, moving from dock to anchorage and anchorage to dock and the general run of work which is characteristic of such a voyage, including in the Panama Canal.

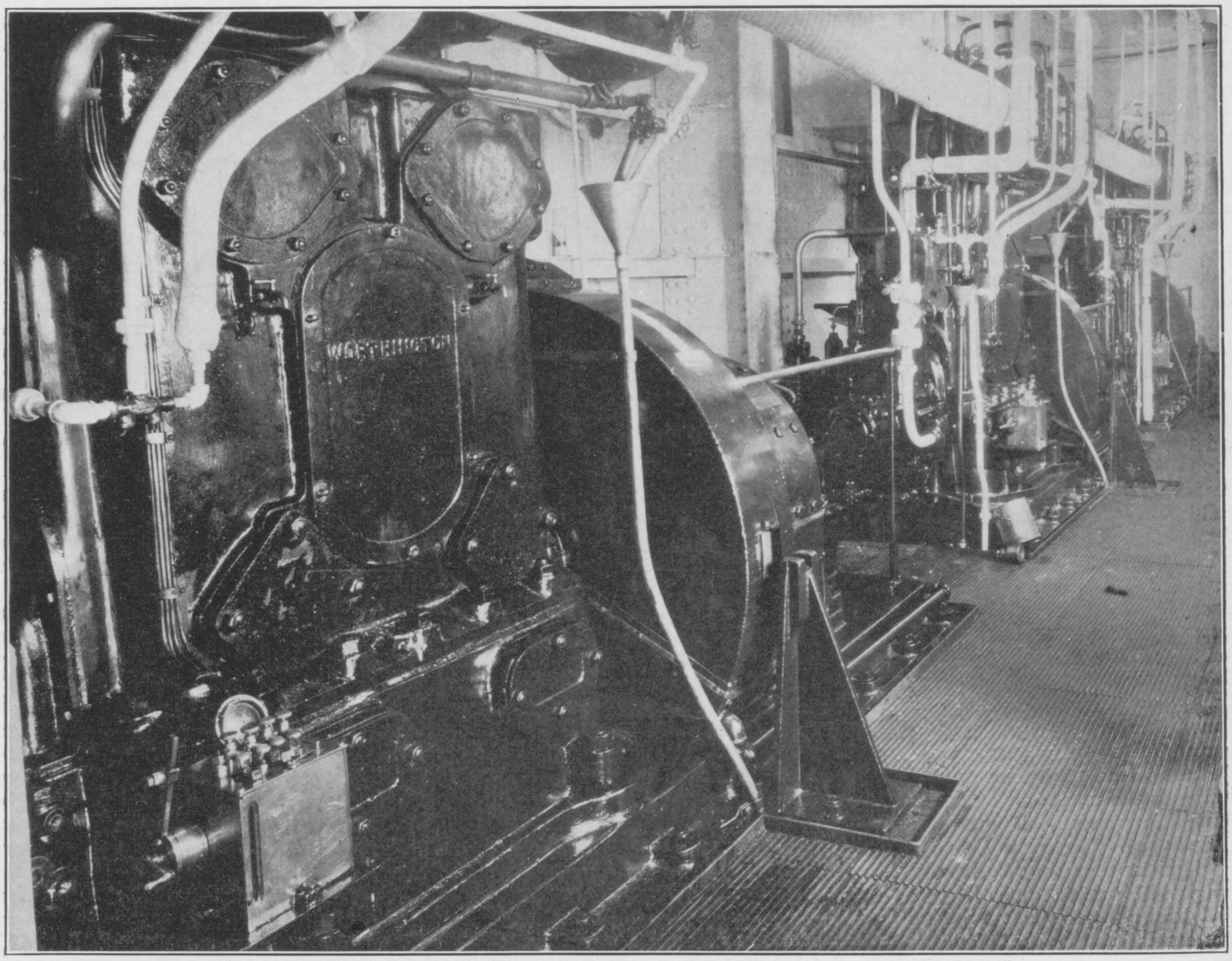
is slower, was 100 tons per hour and would load 5,000 tons in 50 hours. This is a close approximation of what would be the case if the ship were not stopping at every small port along the coast, but was calling at 5 or 6 ports to load or discharge more than 1,000 tons at each.

The steam plant on this motorship on a 10,000 mile voyage would work out about as follows:

Time in port loading and discharging—14 days of 8 working hours each. Time lost in harbor piloting in and out docking, shifting berth, etc.—4 days.

Boiler in use during 14 days of loading and discharging 12 hours per day—168 hours, 4 hours of this time to be used each day for warming up and preparation. Boiler in use while piloting, docking, shifting berth, etc., 12 hours per day,—48 hours. Total time boiler in use—216 hours.

Fuel required for boiler 216 hours at 0.86 bbl. per hr.—193.6 bbls. or 26.44 tons. Note that time allowance for warming-up winches making port, heaving anchor, mooring,



The three Worthington auxiliary oil-engines in the engine-room of the "Ashbee."

etc., are more than ample. On a voyage such as this the ship would spend only 30% of her time in port as compared to 50% on the voyage which she recently completed. The boiler would be in use 14½% of the total time as compared to 24% on the last voyage.

In 27 calls there were 9 in which less than 100 tons of cargo was handled and only 4 ports where more than 1,000 tons were handled. The most cargo handled in one port was 1,477.5 tons and the least cargo handled in a single port was 26 tons. A total of 9,631 tons of cargo was handled.

The average rate of discharge was 640 tons per 8-hour day. If loaded to 5,000 tons at this rate it would require 62.5 hours. The best rate of discharge made on the trip would, if maintained, discharge 1,160 tons of cargo in an 8-hour day or the entire cargo in 34½ hours at a rate of 145 tons per hour.

The average rate maintained where more than 1,000 tons of cargo was handled to and from docks, not lighters which

Naturally the only comparison that can be made between the use of steam for discharging cargo on a steamship and electricity for discharging cargo on a motorship would be a comparison favorable to the latter type of equipment. But the *Ashbee* is a small ship with limited cargo.

It is a question as to whether electrical equipment on a steamship where the same large boiler and other disproportionate parts of the equipment were being used in connection

with generating current as they are in connection with supplying steam direct to the winches, would prove more economical than the steam winch.

When the work of conversion of *Ashbee* was undertaken five principal objects were in view.

First, to provide a practical means of demonstrating in service under all conditions the performance of the main propelling unit.

Second, to prove the practicability and economy of making steam to motor conversions.

Third, to make this ship one of the most economical vessels at sea.

Fourth, to recondition the ship, rectifying all mistakes made in the original construction.

Fifth, to retain as much of the ship's original equipment as possible without sacrificing quality and economy.

The engine and equipment have been tried and proven entirely successful. Remarkable economy has been maintained. The ship in her work and appearance is the same as new. A large portion of the original equipment still remains. The advisability of making conversions has been proven before now and here is further evidence.

By referring to table I we learn that the principal dimensions of the ship are the same. By referring to table II we learn that deadweight-capacity, cubical-content, gross-tonnage, net-tonnage, fuel-capacity, fresh-water capacity, shaft horsepower, propellor-speed and service-speed of the ship have all decreased slightly. However, daily fuel-consumption has been decreased to 0.28% of what it formerly was. The steaming radius has been increased from 12,000 to 28,800 nautical miles and the number of days of fuel supply has been increased from 48 to 120. This means that the deadweight cargo capacity for a 10,000 mile radius has been increased by 737 tons. The loss in cubic capacity has been entirely due to the addition of tween decks in the holds, which has likewise decreased the gross and net tonnage and had nothing to do with machinery installation. The deadweight capacity was affected by the additional tween decks and increased weight of machinery. For a new purely coastwise ship a lighter weight, shorter and slightly faster-running Diesel engine of the same make very probably designed and installed with every satisfaction, and increased deadweight and cubic-capacity thus secured if desired.

Structural changes in the ship were few. A screen bulkhead between boiler and engine rooms was removed. The former settling-tanks for fuel which were originally a part of the structure were removed because they were not suitably located for service in a motor-vessel. The biggest and most expensive job was the removal of the former boiler, engine, and auxiliary-machinery foundations, and constructing new ones. The principal equipment retained was all deck and galley equipment, steam-winches, anchor-windlass, deck steam-piping, steam-heating system, auxiliary condenser, steam-driven dynamo, machine-shop, equipment lathe drill-press, emery wheel, etc., refrigerator coils, propellor-shaft, emergency steering-gear, rudder, telemotor system, lighting system throughout the cabins, wireless equipment and navigating instruments.

The principal new equipment was main propelling-unit, auxiliary oil-engines and generators, auxiliary air-compressors, electrically-driven pumps, donkey-boiler, steam-driven circulating-water pump, air pump for condenser, hydro-electric steering gear, new tail-shaft and propeller, air tanks, new engine-room piping and electric-driven ammonia compressor for refrigeration.

The biggest task in connection with the new machinery installation aside from constructing the engine, and foundation building which is structural, was the new water, oil and air piping, and the electrical work in connection with the new electric machinery in the engine-room.

PARTICULARS OF MAIN ENGINE.

Cycle of operation	4 strokes
Number of cylinders	6
Diameter of cylinders	27″
Piston stroke	47″
Rated R. P. M.	110
Indicated horsepower	2,000
Shaft horsepower	1,500

AUXILIARY ENGINES.

Three Worthington 60 H.P. two cycle, airless-injection oil engines direct-connected to three 40 KW 220-volt General Electric generators.

AUXILIARY AIR-COMPRESSORS.

One Worthington 10½″ x 7½″ x 3½″ x 8″ direct-connected to 100 H.P. D. C. motor. Capacity 225 cu. ft. per min.
One Worthington 4″ x 3½″ x 3⅛″ x 3″ steam-driven compr. 10 cu. ft.

PUMPS.

Five Worthington centrifugal pumps for circulating-water, ballast, fire and sanitary service all direct-connected to G. E. motors.
One Worthington triplex-plunger crank-action gear-transmission from G. E. motor.
Five Blackmer rotary-gear transmission, from G. E. motor drive, 2 for lubricating oil, 2 for fuel-oil and 1 for bilge pumping.

STEAM PLANT.

One Vertical fire-tube boiler with 1,390 sq. ft. of heating surface.
One Small Wheeler condenser.
One Air pump.
One Circulating pump.
One Bilge pump.
One Boiler-feed water pump.

DECK MACHINERY.

Ten Lidgerwood 8′ x 8¼″ winches.
One Hyde hydro-electric steering gear.
One Main Electric Co. steam anchor windlass.

REFRIGERATION.

One Remington ice-machine G. E. motor driven.

LIGHTING.

Original lighting panel and steam-driven dynamo.
One G. E. Ballancing set to work in conjunction with series circuits in converting 220 volts to 110 volts for lighting.

LUBRICATING-OIL FILTERING.

One 20 gal. per hour capacity DeLaval purifier.
One 100 gal. per hour Richardson-Phenix filter.

MACHINE SHOP.

Lathe, drill press, grinder and stone, motor driven with common line shaft.

American Marine Oil Engine Builders

For Main Drive

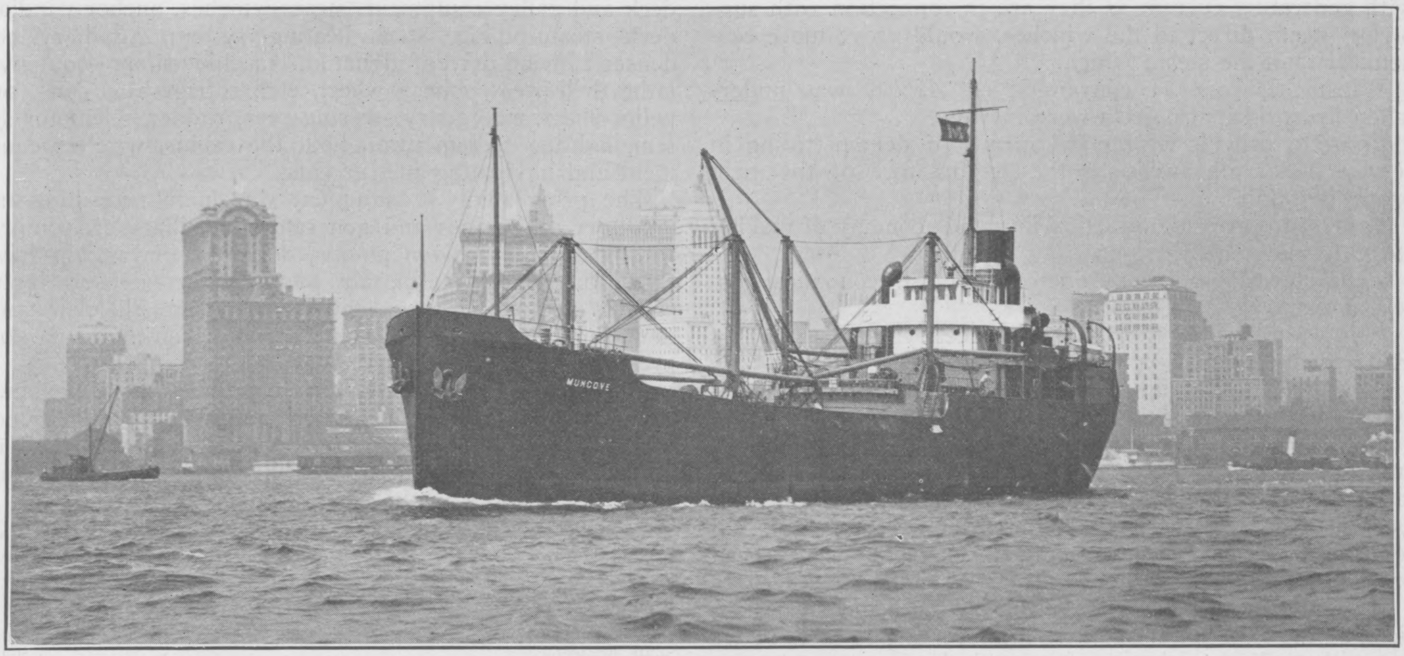
Builder's Name	Address	Design of Engine
Bethlehem Shipbuilding Corp.†	Bethlehem, Pa.	Bethlehem.
Busch-Sulzer Bros. Diesel Eng. Co.†	St. Louis, Mo.	Busch-Sulzer.
Cramp & Sons' Ship & Eng. Co., Wm.†	Philadelphia, Pa.	B. & W.
Falk Corp.*	Milwaukee, Wisc.	Falk.
Hooven, Owens, Rentschler Co.	Hamilton, Ohio	M. A. N.
Ingersoll-Rand Co.*†	New York, N. Y.	Price-Rathburn.
Lombard Governor Co.*†	Ashland, Mass.	Lombard.
McIntosh & Seymour Corp.†	Auburn, N. Y.	McIntosh & Seymour.
New London Ship & Eng. Co.†	Groton, Conn.	Nelseco-M. A. N.
New York Shipbuilding Corp.	Camden, N. J.	Werkspoor.
Pacific Diesel Engine Co.†	Oakland, Calif.	Werkspoor.
Sun Shipbuilding Co.	Chester, Pa.	Doxford.
Winton Engine Works*†	Cleveland, Ohio	Winton.
Worthington Pump & Mach. Corp.†	New York, N. Y.	Worthington.

* In conjunction with reduction-gear or electric drive.
† Also build smaller oil-engines for engine-room auxiliary purposes.

For Auxiliary Power

Builder's Name	Address	Design of Engine
Atlas Imperial Engine Co.	Oakland, Calif.	Atlas.
Bates & Edmonds Motor Co.	Lansing, Mich.	Bull Dog.
Bessemer Gas Engine Co.	Grove City, Pa.	Bessemer-Atlas.
Cooper, C. & G.	Mt. Vernon, Ohio	M. A. N.
Dow Pump & Diesel Engine Co.	Alameda, Calif.	Dow-Willans
Enterprise Engine Co.*	San Francisco, Calif.	Enterprise.
Fairbanks-Morse & Co.	Chicago, Ill.	Fairbanks-Morse.
Kahlenberg Bros.	Two Rivers, Wisc.	Kahlenberg.
Mianus Diesel Engine Co.	New York, N. Y.	Mianus.
Standard Gas Engine Co.	Oakland, Calif.	Standard-Venn-Severin.
Standard Motor Construction Co.	Jersey City, N. J.	Standard.
Union Gas Engine Co.	San Francisco, Calif.	Union.
Venn-Severin Machine Co.	Chicago, Ill.	Venn-Severin.
Washington Iron Works	Seattle, Wash.	Washington-Estep.
Western Machinery Corp.	Los Angeles, Calif.	Western.
Wolverine Motor Works	Bridgeport, Conn.	Wolverine.

* Consolidated with the Western Mach. Corp.



"Muncove," "Ex-Covedale," a Lake-type Shipping Board freighter of 4,125 tons d. w. was a complete conversion, having electrical deck auxiliaries. She is propelled by a 1,200 i. h. p. four-cycle Diesel engine turning a single screw at 140 r. p. m.

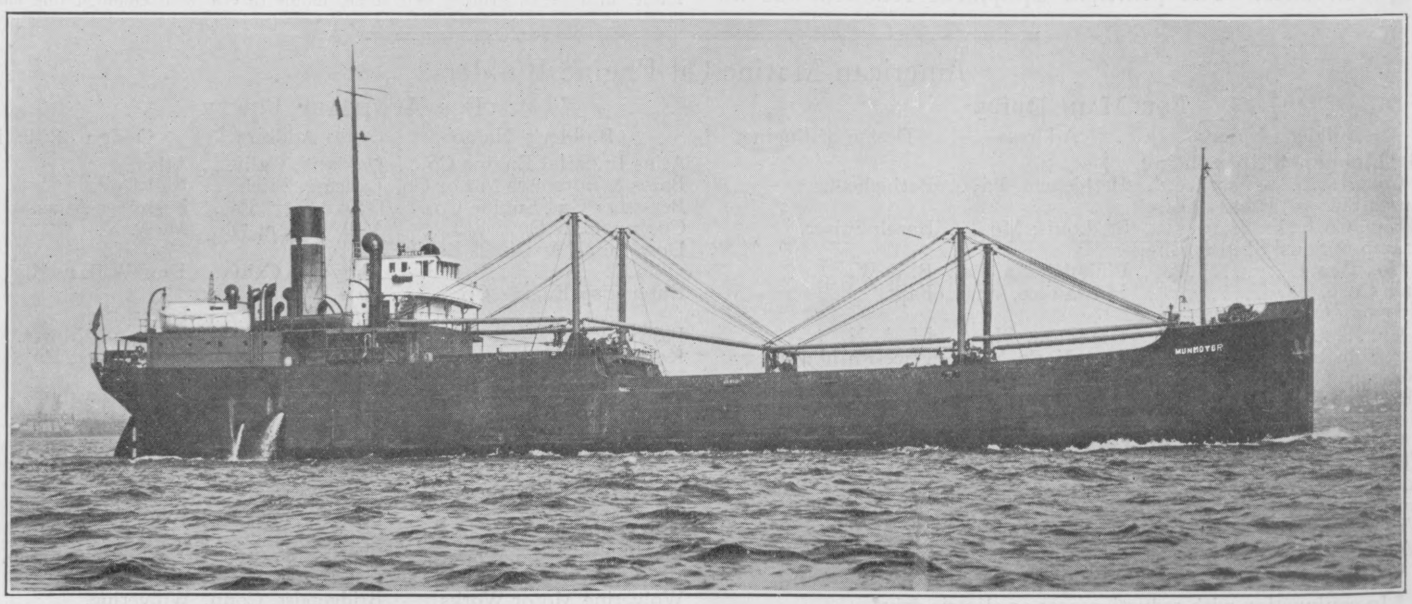
Conversion of Coastwise Ships to Oil-Engine Power.

The "Muncove" and "Munmotor," Formerly the Coal-Burning Steamships "Covedale" and "Courtois," Have Been Converted to McIntosh & Seymour Diesel Propelling Power by the Sun Shipbuilding Company. Their Operation in the Domestic Coastwise Service is Significant, as Their Owner Has Ordered a Third Oil-Engine.

EXAMPLES of the conversion of medium-sized vessels for coastwise service is furnished by the Gt. Lakes' built sister-ships *Muncove* and *Munmotor*, ex *Covedale* and *Courtois*, respectively. Whereas the claim has been made that it rarely pays to use Diesel power for this class of service, we understand that the experience which the Munson Line has had in the operation of these vessels contributes nothing to the support of this belief. In fact this well-known American steamship concern has placed an order for a third Diesel engine for another conversion.

Frank Munson, president of the Munson Line, has been one of the strongest advocates among shipowners in this country for the conversion of existing steamships to Diesel power, having publicly expressed his belief that it is the only solution for placing our foreign-going merchant marine on a firm footing, aside from effecting numerous economies in the operation of our coastwise vessels. His company's experiences also include the running of a small European-built motorship between this country and the Bahamas.

Among the vessels which the Shipping Board has for sale at low prices are a number of Lake-type ships of medium tonnage which, if properly converted to motor power, could



"Munmotor," "Ex-Courtois" is a sister vessel to the "Muncove." When she was converted her steam deck-auxiliaries were retained and proved very uneconomical compared with the electric deck-machinery of the "Muncove." This vessel also has a 1,200 i. h. p. McIntosh & Seymour Diesel engine.

be turned into first-class economical craft for many services along both the Atlantic and Pacific coasts, and the work of conversion can be carried out at costs that are not prohibitive. It is not sufficient, however, to install any old engine that may be available second-hand and operate it in conjunction with old wartime auxiliary equipment that may be on the ships, but the installations should be just as carefully planned and carried-out as any larger ocean-going conversion.

Built originally as Shipping Board steamers by the Great Lakes Engineering Works in 1919, the two steamships *Muncove* and *Munmotor* were converted to McIntosh & Seymour Diesel power several years afterwards by the Sun Shipbuilding Company at Chester, Pa. Their principal dimensions are as follows:

Length over all	261 ft. 9 in.
Length between perpendiculars	253 ft. 6 in.
Breadth moulded	43 ft. 6 in.
Depth moulded	27 ft. 6 in.
Height 'tween decks	7 ft. 6 in.
Gross tonnage	2,450 tons.
Net tonnage	1,485 tons.
Hold capacity	180,765 cu. ft.
Tank capacity	39,550 cu. ft.
Bunker capacity	15,210 cu. ft.

Before conversion the vessels were both powered with a triple-expansion steam engine supplied with steam from two Scotch boilers using coal as fuel. As is apparent from the drawings given, all the machinery and crew accommodation are located aft. General particulars of the original engines and each of the boilers are as follows:

Heating surface	2,080 sq. ft.
Grate area	52 sq. ft.
Steam pressure	175 lbs. per sq. in.
Engine power	1,200 i.h.p.
Engine speed	83 r.p.m.
Cylinder bore, H. P.	21 in.
Cylinder bore, I. P.	34½ in.
Cylinder bore, L. P.	57 in.
Stroke	42 in.

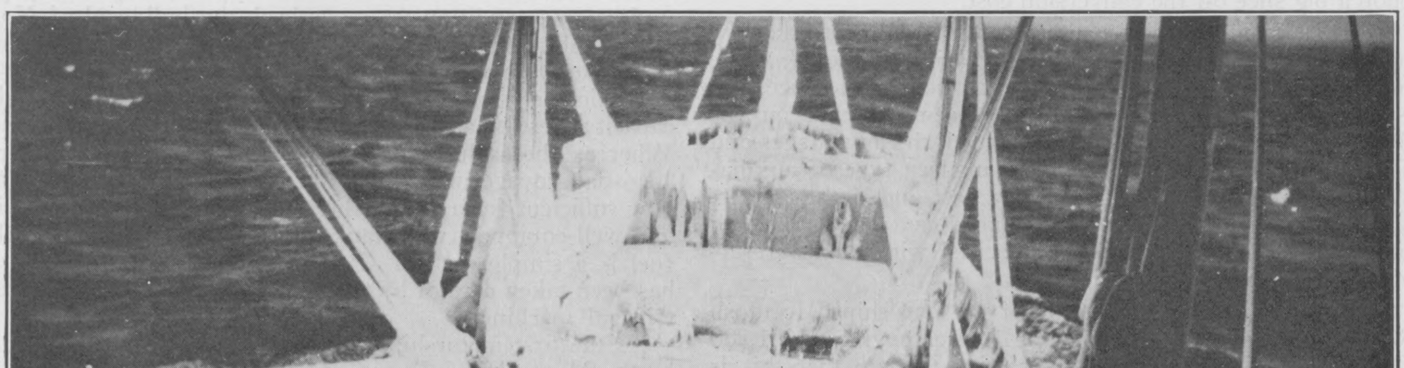
According to actual performance records obtained by the Shipping Board these vessels attained a sea speed of 8.5 knots and the daily consumption of coal, according to the Shipping Board Register, is 25 tons per day. Taking these figures as correct, it would appear that 1.95 lbs of coal were being consumed per i.h.p.-hr., which is about what would be expected from this class of equipment. From what follows, however, it will appear likely, however, that the 1,200 i.h.p. were not actually being developed continuously.

When the conversion of the *Courtois* and the *Covedale* first came up for consideration, one of the deciding factors in reaching a decision was undoubtedly the fact that the Diesel engine could be easily accommodated aft of the existing water-tight engine room bulkhead. In fact there was so much room that in the case of the *Courtois,* now the *Munmotor,* it was decided to leave one of the boilers and steam auxiliaries in the ship.

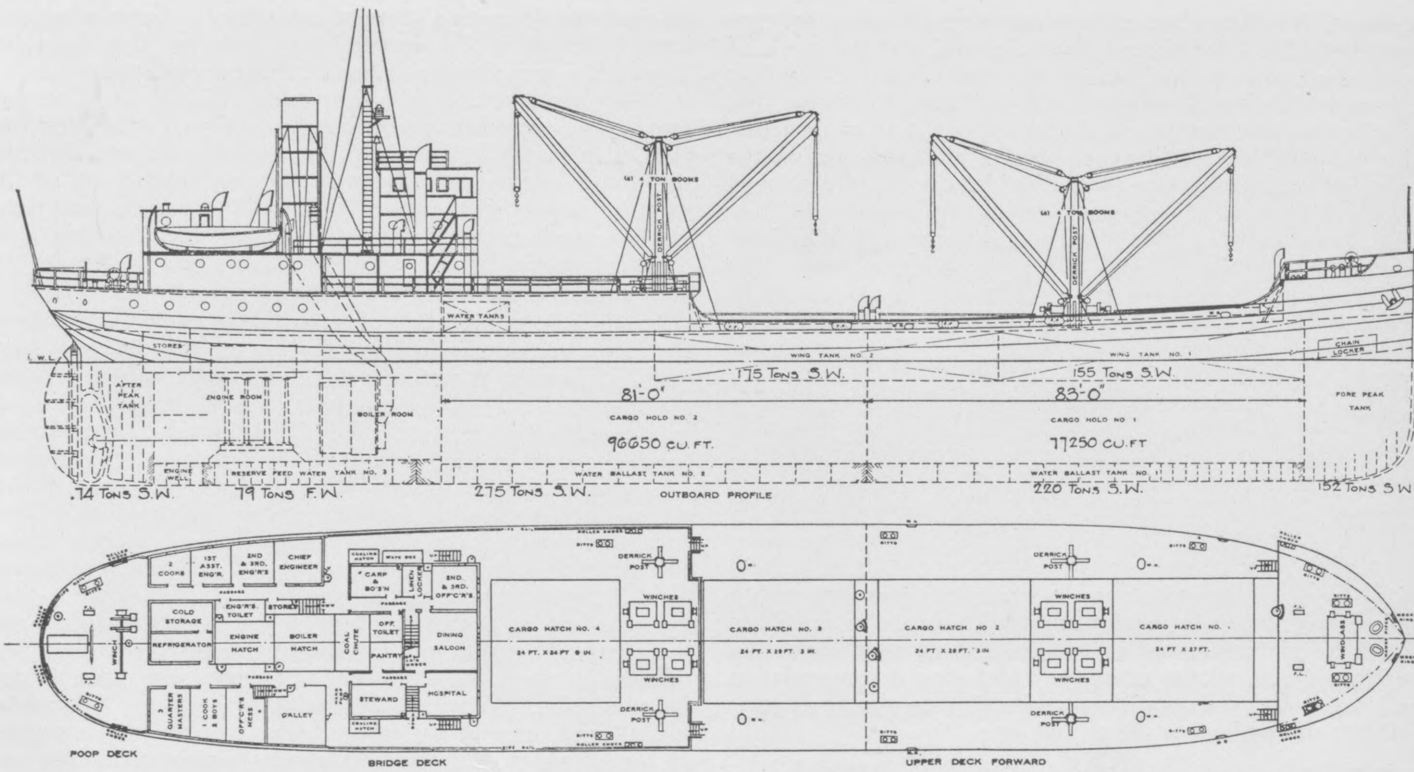
It will be observed that along with the engine and boilers, the entire coal bunkering capacity for the ship had also been installed in what is virtually the engine-room space. As the result of tearing out the bunkers, a large amount of room was made available for the Diesel installation, on the other hand, the cubic cargo-capacity of the ship was little affected.

Complete motorization of the *Muncove* was carried out, all engine-room and deck-auxiliaries being driven with current furnished by three Winton Diesel engines direct connected to 40 kw electric generators. Naturally this auxiliary equipment occupies a considerably smaller space than the cumbersome Scotch boilers which it has replaced and the contrast between the two installations thrusts itself unmistakably upon the attention of anyone who goes aboard the two ships. Whereas the engine-room on the *Munmotor* is cluttered up with the bulky boiler and an intricate mass of lagged pipes, the *Muncove* makes a pleasing appearance because of its simplicity and neatness, aside from the important matter of the resultant economy in operation.

The *Munmotor* (with the steam auxiliaries) was the first to be converted and the retention of the steam auxiliaries may be ascribed to several factors. Leaving one boiler in place, along with the pumps, condenser, hot-well, and the like, undoubtedly looked like the path of least resistance. In assuming, further, that the steam end of the job, based on mankind's 100 or more years of steam operating and designing experience would take care of itself, the very real complication and messiness of steam apparatus was underesti-



Careful planning of the conversion of coastwise ships is just as important as with larger ocean-going type vessels. Example of severe weather to be occasionally met on our offshore routes is shown by the above illustration of the "Muncove" en route from Norfolk to Portland in the throes of winter weather.



Inboard profile and deck plan of the "Muncove" and "Munmotor" type of cargo ship prior to conversion.

mated. Contrary to the original expectation, it was the steam machinery, and not the Diesel which later required the closest watching. In the earlier days of Diesel installations it was not unusual to find that the oil engine was regarded more or less as black magic, the less of it the better.

Another factor which was partly responsible for the retention of steam on the *Munmotor* was undoubtedly the extra first cost of electric auxiliaries. The latter had to be purchased new, whereas the steam machinery actually found in place and in working order would, if retained, naturally chop a big slice off the conversion cost.

In spite of all this, it is said on reliable authority that the operation of the Diesel-electric auxiliaries on the *Muncove* has been decidedly superior, both as regards service and economy to the results which have been obtained on the *Muncove*. As far as can be ascertained, the advantages and savings due to the use of the more modern type of auxiliaries has completely offset their extra cost and if the conversion job on the two ships were being done over again, both of them would be completely motorized without any reservations whatever.

For the main propelling units of the two ships McIntosh & Seymour crosshead four-cycle Diesel engines of 1,200 i. h. p. were chosen. It is interesting to note that this is exactly the same as that of the steam engine which was taken out. Naturally the Diesel engine delivers less shaft horsepower (900 at 140 r. p. m. to be accurate) than the slower-speed steam engine; nevertheless operating records show that the *Muncove* was changed from an 8½-knot ship to a 9-knot ship as the result of her conversion. Because of the settled policy of the shipping firm which has operated both vessels since they were changed over, no data is being given out concerning them while Frank Munson is absent from this country on a visit to Europe. It is therefore not possible for us to support our statements about them at this time with the same wealth of official figures that accompany our articles on other ships that have been converted.

As has already been pointed out, the hulls of the *Munmotor* and the *Muncove* were little affected by the conversions and their cubic cargo-capacities have not been much changed. The coal bunkers were simply removed from the engine-room and the space which was gained improved the installation.

With further conversions of this type of ship it may pay under some conditions to move back the bulkhead of No. 2 cargo hold, and thus gain bulk cargo capacity. The question of cost, however, may be the deciding factor.

Particularly important, however, is the increase in weight-capacity resulting from the use of the Diesel engines. Whereas these ships had to carry 338 tons of fuel for a 13½-day voyage under steam power, 81 tons of fuel oil are now sufficient for a run of the same length. Since the ships are well-equipped with tanks, the accommodation of this fuel is a simple matter. Purification of the lubricating oil has been taken care of by the installation of a De Laval centrifugal machine.

As the first motorships which have been placed in service by the Munson Line, it was only natural some of the earlier experiences had with them were not free from minor troubles, but that has not prevented officials of the line from expressing their general satisfaction with their motorized vessels. In fact, they are so thoroughly convinced of the savings and operating advantages rendered possible by the use of the heavy-oil engine that their name is being mentioned in connection with the third marine Diesel installation referred to, which is now being worked on at the Sun Shipyard in Chester.

Annual Wages of American Steamers, and Single-Screw and Twin-Screw Motorships, also of a British Twin-Screw Motorship

Engine-Room Crew	7,750 Tons d.w. Vessels		12,000 Tons d.w. Vessels			British Twin-Screw Motorship (Basis £1 = $4.37)
	Seekonk as a Single-Screw Steamer	**Seekonk** as a Single-Screw Motorship	Shipping Board's Twin-Screw Motorship **William Penn**	American-Hawaiian Co's. Twin-Screw Motorship **Californian**	American S. O. A. Wages for Steamers	
	No. of men	*No. of men*	*No. of men*	*No. of men*	*No. of men*	*No. of men*
Chief engineer..........	(1) $3,168	(1) $3,300	(1) $3,780	(1) $3,900	(1) $2,820	(1) $1,600
First assistant..........	(1) 2,420	(1) 2,204	(1) 2,520	(1) 2,280	(1) 1,980	(1) 1,220
Second assistant........	(1) 1,980	(1) 2,040	(1) 2,280	(1) 2,040	(1) 1,680	(1) 909
Third assistant.........	(1) 1,800	(1) 1,860	(1) 1,980	(1) 1,650	(1) 1,500	(1) 682
Fourth assistant (or jun. 3rd asst.)............	(0)	(0)	(1) 1,620	(1) 1,500	(2) 2,160	(1) 550
Chief electrician........	(0)	(1) 1,560	(1) 2,040	(1) 2,040	(0)	(1) 600
Assistant electrician.....	(0)	(0)	(1) 960	(0)	(0)	(0) ....
Machinist..............	(0)	(0)	(1) 960	(0)	(0)	(0) ....
Senior motormen (or oilers)................	(3) 2,718	(4) 3,624	(3) 2,700	(5) 3,900	(3) 2,340	(3) 1,889
Junior motormen (or wipers)..............	(0)	(0)	(3) 2,070	(3) 1,800	(2) 1,200	(3) 1,650
Watertenders...........	(3) 2,718	(0)	(0)	(0)	(3) 2,340	(0) ....
Firemen................	(6) 4,716	(0)	(0)	(0)	(3) 2,070	(1) 551
Total.............	(16) $19,520	(9) $14,588	(14) $20,910	(14) $19,110	(17) $18,090	(13) $9,651

In the case of the large vessels given the food, for the three additional men carried by the steamers make the wage and maintenance bill approximately equal.

Disposal Prices of Shipping Board Vessels Under Conversion Contract.

Considerable apprehension has been felt over the question of the prices at which Shipping Board hulls will be sold for conversion to Diesel power by private shipowning concerns. This fear has arisen because the recent Amendment to Section Twelve of the Merchant Marine Act of 1920 clearly stipulates that vessels converted by the Board cannot be sold within five years unless at an amount not less than $10 per d.w. ton plus the cost of re-conditioning and less a 5% annual deduction for depreciation.

However, it is also clear that Congress had no intention of requiring this stipulation to be laid down in the case of conversions made to Board ships by private shipowners under the terms of the Amendment to Section Eleven, which is distinct from Section Twelve. Private shipowners in their conversions are faced with a considerable number of expenses relating to preparing plans and specifications, transferring the hulls to the shipyards, supervision of conversion and engine construction, etc., which costs in the case of the Board's own conversions are absorbed in the general operating expenditures of the Board.

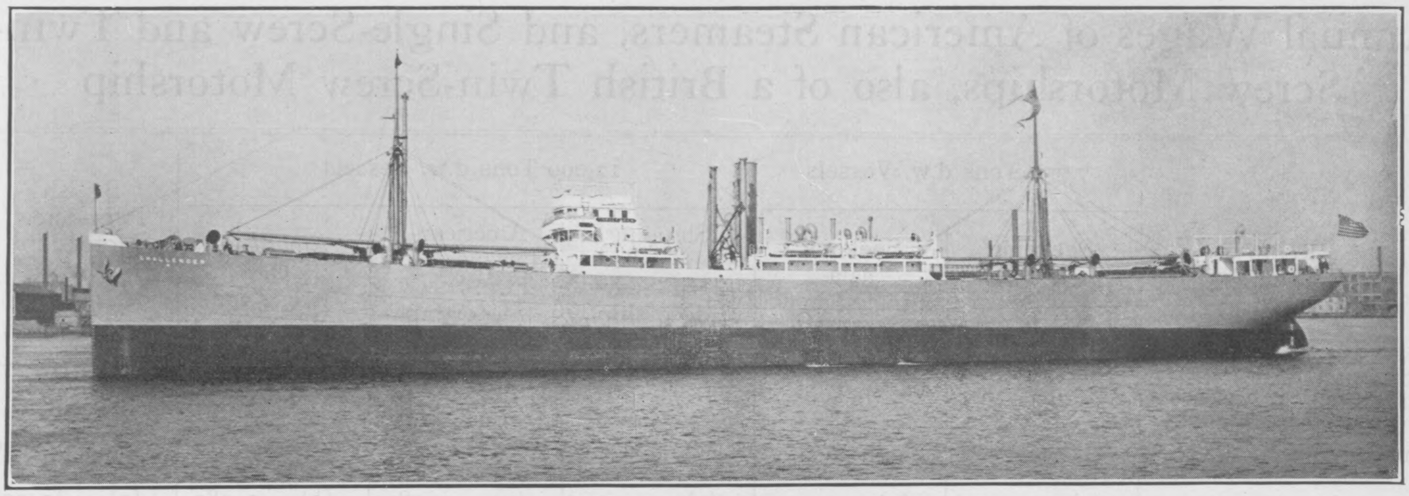
It is the personal understanding of J. Harry Philbin, manager of the Board's Department of Ship Sales, that ships sold for conversion to Diesel propulsion by the purchaser are to be continued to be offered for sale on hull valuations at prices fixed by the Board, which will vary according to the physical characteristics of the individual vessels. Should a loan be required from the Shipping Board on a vessel bought for conversion purposes, it is possible that a slightly higher price would be required. These questions are policies which will be determined by the Board as they arise in actual cases. The hull must be paid for in cash.

Possible Conversion to High-Power Diesel-Electric Drive

While no definite decision has yet been made, it is possible that three 1,200 b.h.p. Diesel-driven generator sets and a 2,800 s.h.p. electric propelling motor will be installed in the Standard Oil Company of California tanker *K. R. Kingsbury* and her existing steam machinery scrapped. Bids have been received but no action has yet been taken.

Standard Oil of N. J. Converting Three Tankers

An order has been placed with Krupps of Kiel, Germany, by the Standard Oil Co. of New Jersey to build and install 2,150 s.h.p. single-screw Diesel engines in the geared-turbine tankers *Josiah Macy, S. B. Harkness,* and *Trontolite*. These vessels were only built about four years ago. Their conversion illustrates how the geared-turbine is being supplanted by the more economical and more reliable oil-engine.



All steam deck-machinery, as well as the engine-room equipment was ripped-out when the Sun Shipbuilding Company converted the single-screw 11,620 tons d. w. Bethlehem-type steamer "Challenger" to Sun-Doxford Diesel power. Worthington and Mianus auxiliary oil-engines were installed.

Opposed-Piston Oil-Engine Drive in Three Converted Ships

Tankers "Bidwell" and "Miller County" and the Freighter "Challenger" Are Equipped with the Highest Power on a Single-Shaft of All Shipping Board Vessels Yet Converted, and Without Increasing the Machinery Space.

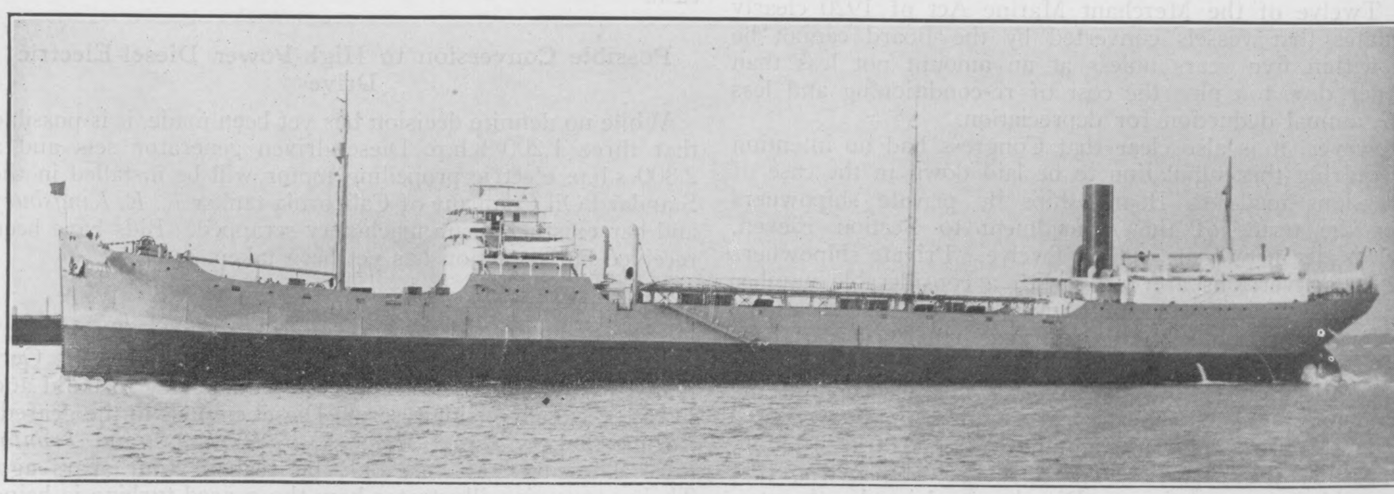
ALL the other converted Shipping Board ships dealt with in this Supplement have been equipped with single-acting, two-cycle or four-cycle, Diesel engines, although one is to use electric transmission with high-speed motors of this type. The 10,260 tons d.w. tankers *Bidwell* and *Miller County* and the 11,620 tons d.w. cargo-boat *Challenger,* are the first American-built ships and are the first conversions to have the opposed-piston type of oil-engine, as well as being the first high-powered American installations in service with the airless system of fuel injection. Furthermore, until the advent of the two Ford motorships with the same make of engine they ranked as the World's highest-powered single-screw motorships, their engines developing 3,060 shaft h.p. at 90 r.p.m., or 2,740 s.h.p. at 77 r.p.m. from four-cylinders 22¾″ bore and twice 45½″ stroke.

All three vessels were converted by the Sun Shipbuilding Co., Chester, Pa. Originally they were equipped with geared-turbines and Scotch boilers. The dimensions of the *Bidwell* and *Miller County* are the same, and are as follows:

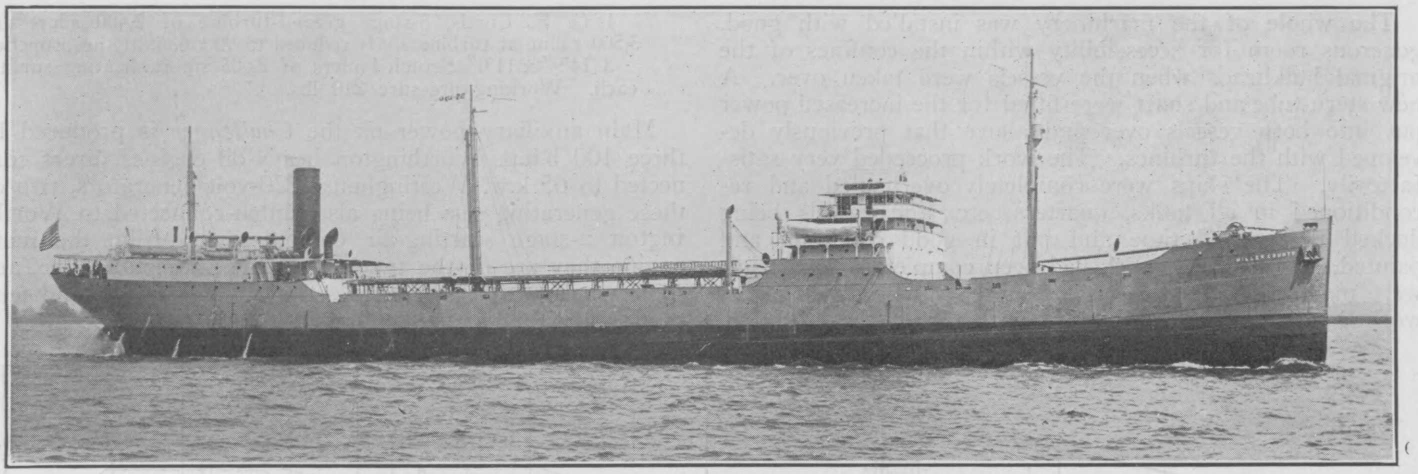
M. S. Bidwell and M. S. Miller County

Loaded displacement	14,760 tons.
Light displacement	4,500 tons.
Deadweight capacity	10,260 tons.
Power (effective)	2,740 to 3,060 s. h.
Engine-speed	77 to 90 r. p. m.
Ship's average sea speed	10.3 knots.
Best sea speed	12½ knots.
Propeller diameter and pitch	17′ 9″ by 13′ 9″
Daily sea fuel-consumption (respectively)	9.3 and 10.3 tons.
Daily port fuel-consumption	3 tons.
Length b. p.	430′ 0″
Breadth, md	59′ 0″
Depth, md	33′ 3″
Draft, mean	25′ 4½″
Weight of main Diesel engine including flywheel and thrust-block	370 tons.
Weight of engine-room machinery including Scotch boiler and steam auxiliaries and main engine	758 tons.
Engine-room staff	13 men.

These two ships retained their steam auxiliaries including the cargo pumps, but the *Challenger* was equipped with Diesel-electric auxiliaries, which have proven much more economical, even taking into consideration overhead on the additional cost. The *Challenger's* dimensions are as follows:



Single-screw 10,200 tons d. w. 2,700 s.h.p. Shipping Board turbine-driven tanker "Bidwell" converted to Sun-Doxford 3,060 s.h.p. at 90 r.p.m. or 2,740 s.h.p. at 77 r.p.m. opposed-piston Diesel engines. The steam auxiliaries were retained in her engine-room and pump-room.

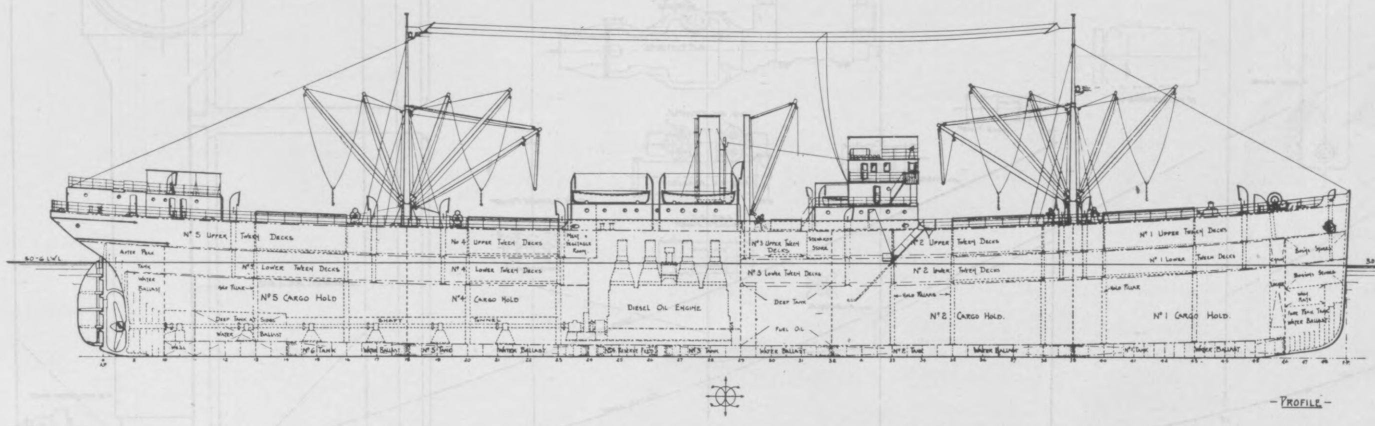


The "Miller County," another Shipping Board tanker and sister to the "Bidwell" in which steam auxiliaries were also retained. She too has a Sun-Doxford Diesel engine.

M. S. Challenger

Loaded displacement	15,930 tons.
Light displacement	4,310 tons.
Cubic capacity of holds, and deep tank for cargo	583,530 cu. ft.
Deadweight capacity	11,620 tons.
Fresh water capacity	140 tons.
Length of machinery space	50′ 0″
Power (effective)	2,740 to 3,060 s. h. p
Power (indicated)	3,200 to 3,600 i. h. p.
Engine speed	77 to 90 r. p. m.
Ship's average speed on round-world voyage	9.73 knots.
Ship's best sea speed	13.85 knots.
Propeller, diameter, pitch and area	17′ x 16′ 6″ x 98 sq. ft.
Daily sea fuel consumpion	12 tons.
Daily port fuel consumption	$1\frac{1}{3}$ tons.
Lubricating oil consumption per day	18 gals.
Engine-room staff	11 men.
Power of auxiliary oil-engines	300 b. h. p.

The *Bidwell* and the *Miller County* were built just after the end of the War by the Baltimore Dry Dock & Shipbuilding Co. When conversion work was started on the tankers they were put in the wet dock and the work of dismantling of the machinery proceeded with. The main turbines and the center and starboard main boilers were removed, and such steam auxiliaries as were unsuitable for the new power were also scrapped. The existing auxiliaries that were retained were relocated, and new foundations built and such other auxiliaries as were required were provided for, the main engine foundations were constructed and a new Sun-Doxford main Diesel of the four-cylinder, two-cycle type installed in each hull together with some new auxiliaries. The port boiler at the forward end of the machinery space was retained in its original position as when the vessels were steamers; the only work done was to case the boiler in, except at the fore end, where the entrance is into the fireroom. This arrangement meant a minimum of structural alterations.

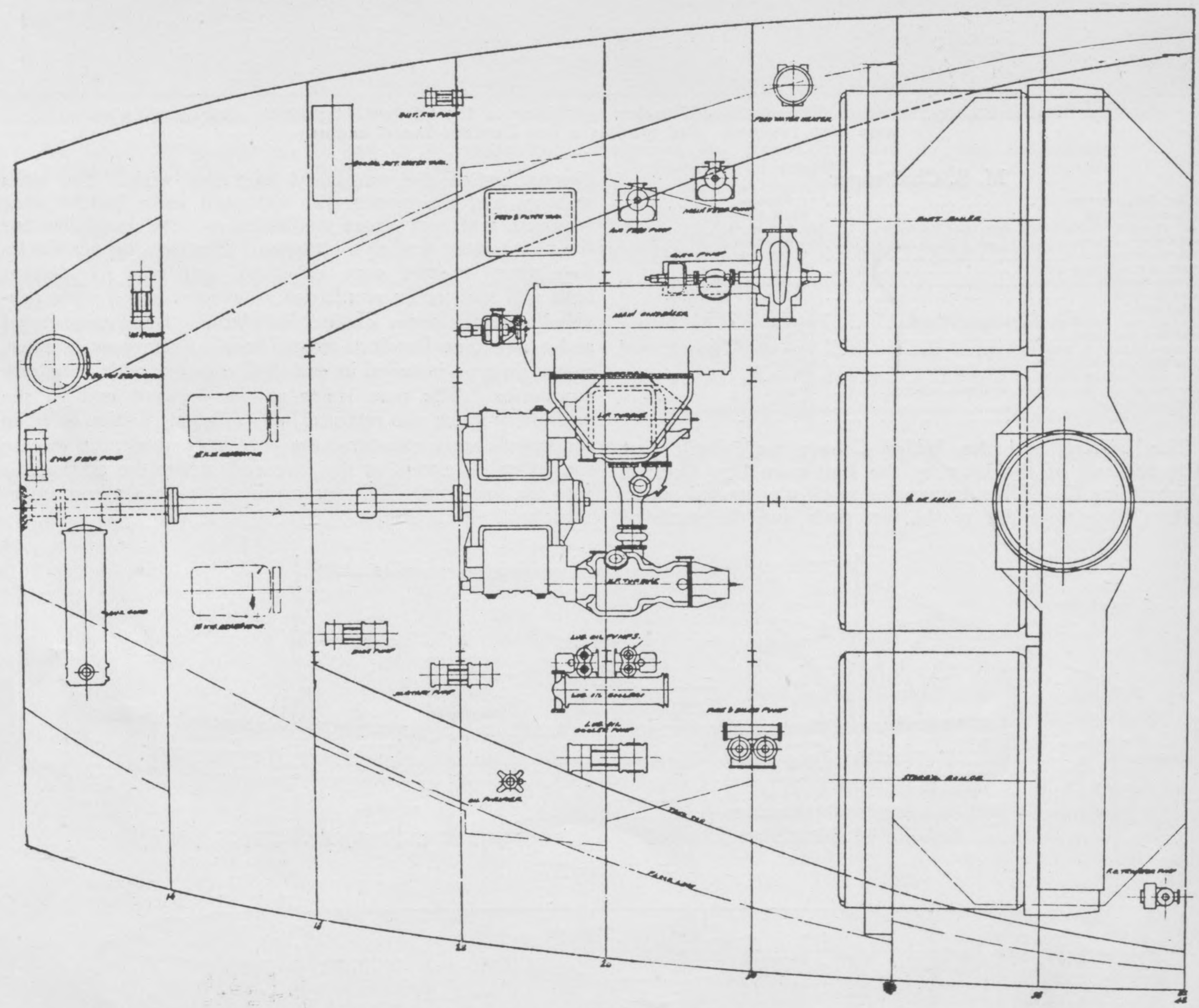


Inboard profile and plans of the motorship "Challenger," formerly a Shipping Board steam-driven freighter.

The whole of the machinery was installed with good, generous room for accessibility within the confines of the original bulkheads when the vessels were taken over. A new stern-tube and shaft were fitted for the increased power put into both vessels over and above that previously developed with the turbines. The work proceeded very satisfactorily. The ships were completely overhauled and reconditioned in all tanks, quarters, etc., the vessels being docked the second time and put in good condition and painted, and after the work had been completed, dock trials were made while the vessels lay at the yard. The engines worked uncommonly well, without the slightest vibration.

1 G. E. Curtis, 5-stage geared-turbine of 2,400 s.h.p. and 3,500 r.p.m. at turbine shaft reduced to 90 r.p.m. at the propeller.
3 14'9" x 11'0" Scotch boilers of 2,605 sq. ft. heating surface each. Working pressure 210 lbs.

Main auxiliary power on the *Challenger* is produced by three 100 b.h.p. Worthington heavy-oil engines direct connected to 65 k.w. Westinghouse 220-volt generators, two of these generating sets being also clutch-connected to Worthington 2-stage starting-air compressors. Like the main engine they are of the two-cycle, airless-injection type, and so dispense with the high-pressure air-compressor and tend to simplify the entire installation.



Engine-room plan of the "Bidwell" prior to conversion showing reduction-geared turbines and three boilers.

The Sun Co. was without data as to whether these hulls would set up vibration with this machinery being so far aft, but were agreeably surprised to find that the working of the machinery developed a steadiness beyond that obtainable, even with their own quadruple-expansion steam-engines, although the Diesels were not erected or run in the shop before installation.

It is our understanding that if the Sun Shipbuilding Company converted any additional tankers, that the steam auxiliaries would be discarded in favor of Diesel-electric equipment including for the cargo pumps, utilizing an exhaust-gas device for steam heating the cargo coils.

The freighter *Challenger*, built by the Bethlehem Shipbuilding Corpn. originally was fitted with the following equipment:

An emergency set which was installed consists of a Mianus oil-engine direct connected to a 10 k.w. Westinghouse 110-volt generator. This engine has a special type of airless-injection pre-combustion chamber somewhat similar to the one in the Worthington machines. A separate high-pressure fuel-pump used for starting the main engine is also available as a standby in case the built-in pump should be prevented from operating. It was built at the Sun yard. To clean and purify the fuel and lubricating oils, De Laval centrifugal purifiers were installed. These are driven by 2 b.h.p. General Electric motors.

There is a 2-ton Brunswick ice machine driven by a 5 h.p. 220-volt Diehl motor; also a 7½ h.p. Westinghouse D. C. motor for running the machine shop and a 15 k.w. motor-generator set for the lighting system.

Worthington pumping equipment for a variety of engine-room services is installed with Westinghouse electric-motor drive as follows:

2-550 G. P. M. Fresh-Water Reciprocating Pumps.
1-550 G. P. M. Salt-Water Centrifugal Circulating Pump.
1-150 R. P. M. Fuel-Oil Rotary Transfer Pump.
1-550 G. P. M. Bilge, Ballast, and Fire, Reciprocating Pump.
1-125 G. P. M. Engine-room Reciprocating Bilge Pump.
1-250 G. P. M. Centrifugal Circulating-Pump for Lubricating-Oil Cooler.
1-200 G. P. M. General-Service Centrifugal Pump.
1-150 G. P. M. Sanitary and Auxiliary Engine Centrifugal Circulating Pump.
1-50 G. P. M. Fresh-Water Reciprocating Pump. Steam or Air Driven.
1 Donkey-Boiler Feed Pump.
1 Horizontal Duplex Fuel-Oil Service Pump.

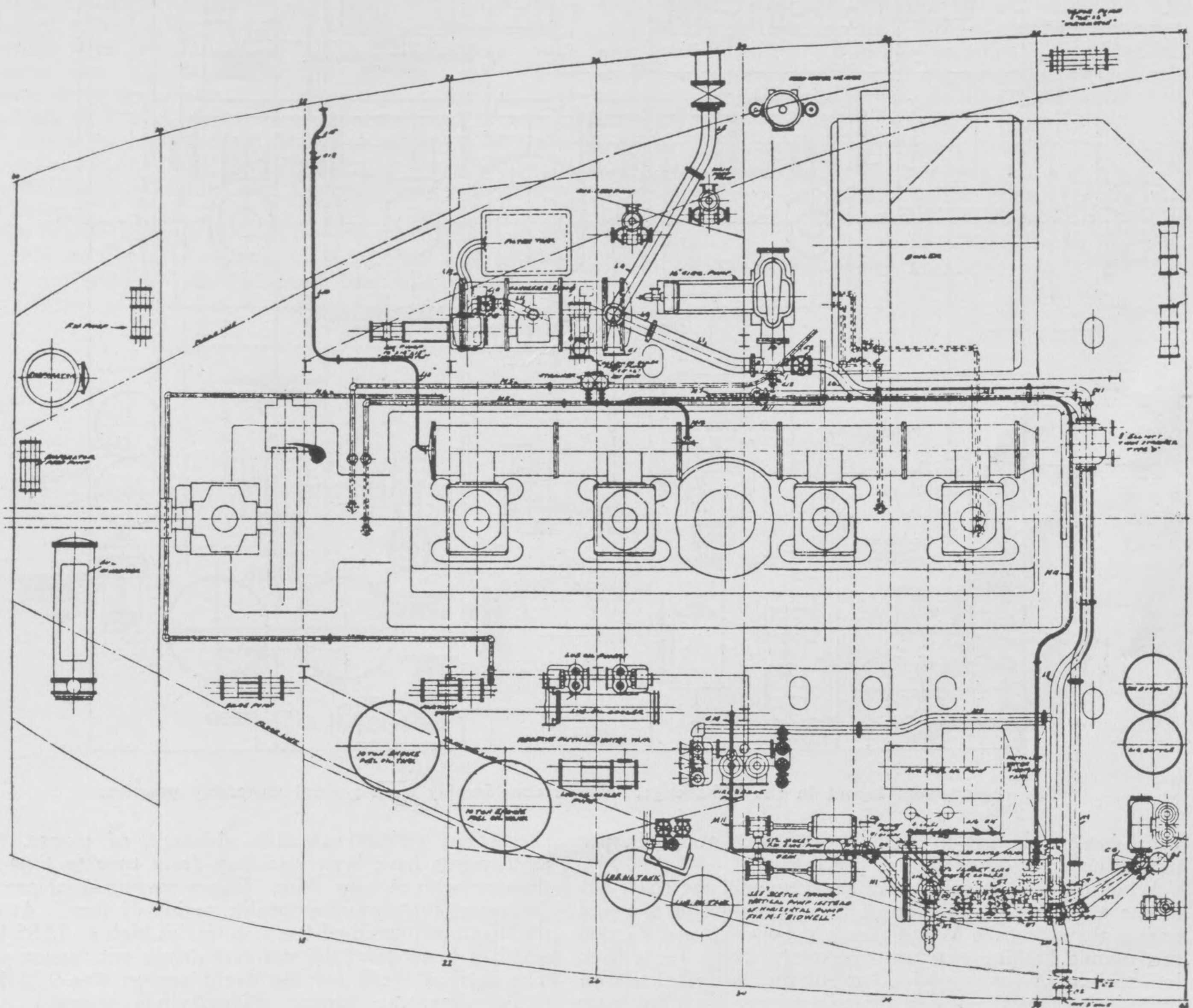
An interesting feature of the conversion, and a product of the Sun Shipyard's engineering department is an exhaust-gas boiler of 1,046 sq. ft. heating surface designed to operate at 125 lbs. per sq. in. for utilizing the waste-heat from the main engine while the latter is running under full power. During maneuvers or stoppage this boiler is kept in service by means of fuel-oil burning equipment served by a Worthington pump. Steam from this boiler is used for general heating purposes and for maintaining fuel-oil and main engine cylinder-jackets at the right operating temperatures. As there is also a separate oil-fired boiler for these purposes, ample standby heating facilities are available.

Further Sun products are:

1 300 sq. ft. Auxiliary Condenser.
2 Starting Air Tanks of 110 cu. ft. each at 700 lbs. per sq. in.
2 10 Ton Daily Service and Settling Tanks.
2 520-gal. Engine Lubricating-Oil Tanks.
1 Lubricating-Oil Cooler of 252 sq. ft. surface.
1 Distilled-Water Cooler of 2,000 sq. ft. surface.

On deck the A. E. Co. electric windlass is a reconstructed machine, rebuilt, retaining the mechanical parts originally installed for the steam windlass, with the addition of a 45 h.p. Westinghouse electric motor, driving the original crankshaft through brass bevel and spur gears. To insure rigidity and perfect alignment, the motor is mounted on an extended bedplate bolted against the present windlass bedplate.

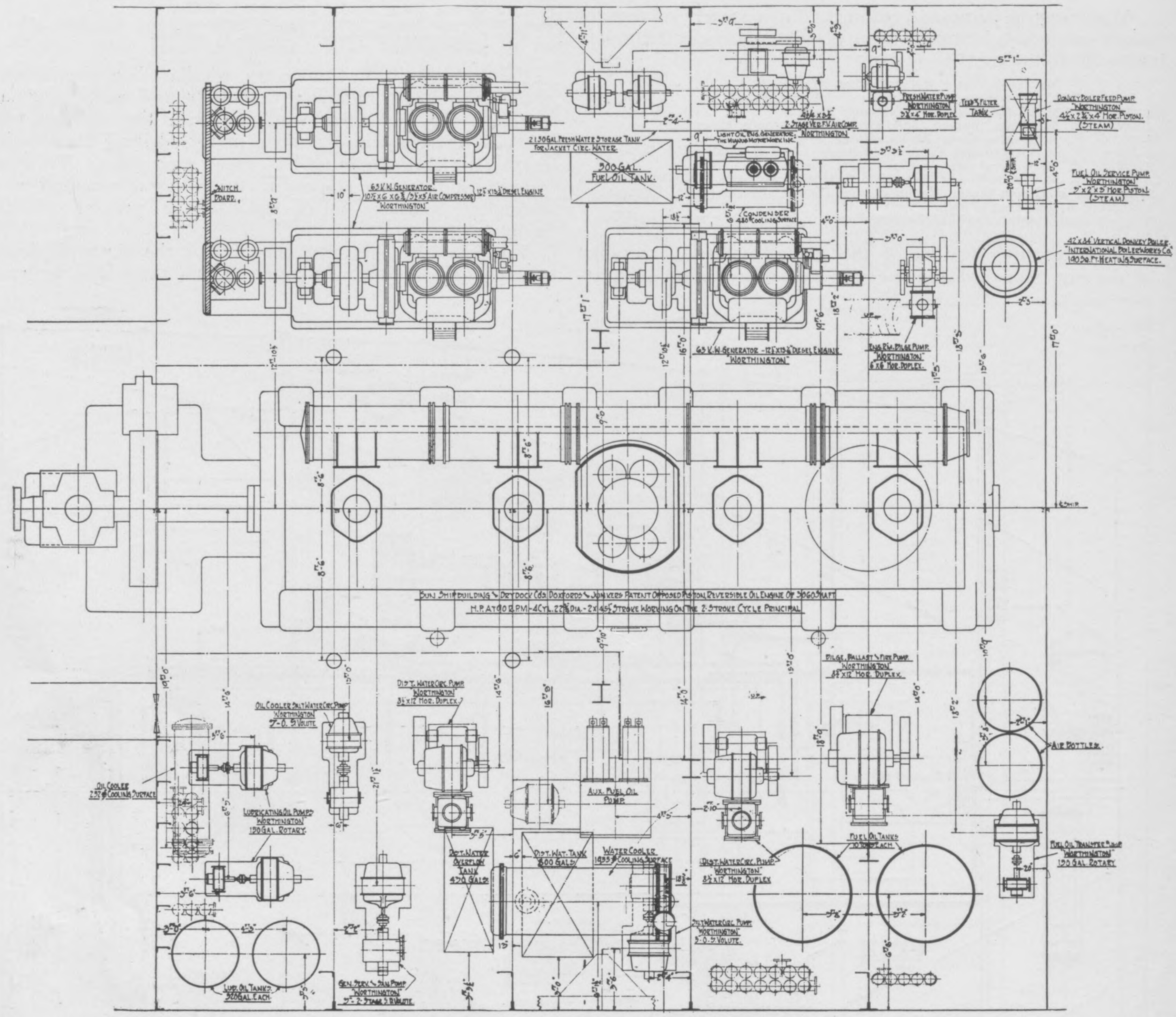
Furnished by the same company is the electro-hydraulic steering gear, which consists of two rams and hydraulic cylinders located athwartships and connected to the rudder stock through a tiller and trunnion.



Engine-room plan of the "Bidwell" showing her present arrangement of Sun-Doxford 2,740 s.h.p. at 177 r.p.m. main Diesel engine and Worthington auxiliaries. At 90 r.p.m. this engine will develop 3,060 s.h.p.

Electric winches of a compact design have also been furnished by the American Engineering Company; they are of the single-drum type in which the winch head is mounted on the drum shaft, the latter being driven through spur gears by a Westinghouse electric motor. It has a rope speed of 250 ft. per minute and a rope pull of 3,500 lbs.

For heavy service there is also a double-geared electric winch generally similar to the machine just described, but it can be operated at two speeds and is equipped with outboard bearings for an extended drum-shaft carrying two



The engine-room layout in the "Challenger" differs considerably from general motorship practice.

winch-heads. It has a capacity of 5 tons at 80 ft. per minute or 2½ tons at 160 ft. per minute.

When the load is sufficiently heavy to pull the slack out of the winch ropes and drop of its own weight on the pier or into the hatch, the Westinghouse deck-winch motors, due to dynamic braking generates electricity which feeds back into the circuit for supplying current for the peak loads on the other winches. During the trial trip of the *Challenger* such a test was made with a winch lifting a 7,000 pound load and 20 amperes of current was generated by the motor on the downward swing of the load.

We now come to the matter of operation in service of these three converted vessels. The *Challenger* has just returned from a voyage around the world handling general cargo, covering approximately 25,000 nautical-miles. She encountered all kinds of weather including adverse winds and rough seas, which is to be expected on such a long trip. In every case she handled very well with absolute absence of serious casualties although, of course, minor adjustments have been necessary from time to time as is the case with all new ships. There was no disablement of the vessel for any unreasonable period of time. At times the maximum speed of the ship was as high as 13.85 knots, which is faster than she was ever driven with steam power. The average speed for the world voyage was 9.73 knots.

To date the tanker *Bidwell* has covered 55,376 nautical miles at an average speed of 10.2 knots from bar to bar. This on a daily fuel-consumption of 72 bbls. or 10⅓ tons per day. This speed does not take into consideration slowing down in fog, reducing speed in heavy weather or stops.

The *Miller County* has done even slightly better, having covered approximately 66,500 nautical-miles at an average of 10.26 knots from bar to bar on a daily fuel-consumption of 65 bbls. or 9⅓ tons of oil. These performances speak for themselves.

Fourth Shipping Board Tanker Sold For Conversion

"Lio," a 10,250 Tons d.w., 2,650 s.h.p. Geared-Turbine Ship Will Have Her Machinery Replaced by a Two-Cycle, Single-acting Diesel Engine of 2,800 s.h.p. at 85 r.p.m. which Will Give Her a Better Average Speed, and at the Same Time Reduce Her Daily Sea Fuel-Consumption from 28 Tons to 12 Tons per Day.

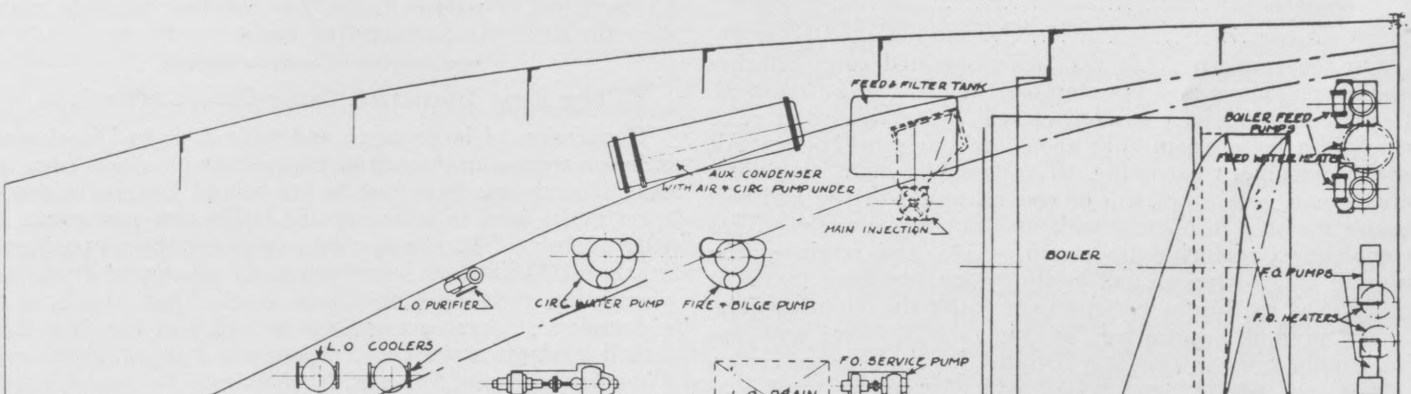
THAT oil-companies operating tankers as well as cargo shipowners intend to take full advantage of the Board's low sales price for steam-vessels purchased under guarantee of conversion to motor power is definitely indicated, although there would be a more active market if the hulls were from 15,000 to 20,000 tons capacity each. Already two big tankships, the *Bidwell* and *Miller County,* have been converted and placed in service, and two more have been bought for this purpose; one of which, the *Allentown,* re-named *J. W. Van Dyke,* is to have Diesel-electric drive, the plant consisting of three 750 b.h.p. Ingersoll-Rand oil-engines and General Electric generators and motor.

The fourth tanker is the *Lio*, recently purchased from the Board by the General Petroleum Corporation of Los Angeles, to be converted by the Bethlehem Shipbuilding Corporation's Union plant at San Francisco, Cal. At present the *Lio* is equipped with three Scotch boilers and a 2,650 s.h.p. geared-turbine turning the propeller at 90 r.p.m., and in the existing machinery space a six-cylinder 27″ by 60″ single-acting, two-cycle Bethlehem Diesel engine of 2,800 s.h.p. at 85 r.p.m. will be fitted. Not only will the new engine give her a better average speed—we estimate from one-half to one knot partly because of the even propeller turning moment—but will reduce her sea fuel-consumption from about 28 tons to 12 tons per diem.

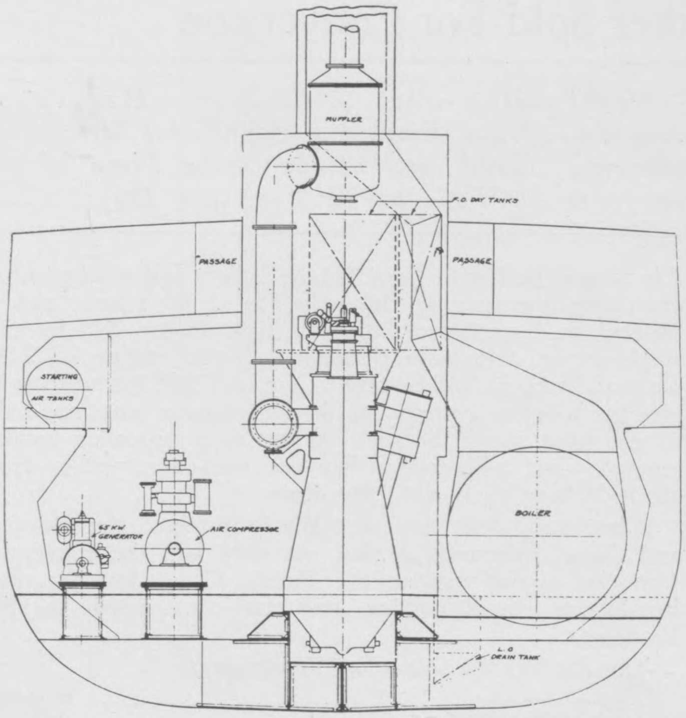
What will doubtless particularly interest the shipping and Diesel industries is that not only will the conversion work be carried out on the Pacific Coast, but the main Bethlehem Diesel engine will be constructed in San Francisco.

The *Lio* has the following dimensions:

Cargo capacity	83,144 bbls.
Dry cargo capacity	35,883



Engine-room plan of the "Lio" as she will look when converted.



Cross section of the engine-room of the "Lio" after conversion.

Length b. p.	430′
Breadth md.	59′
Depth, md.	33′ 3″

On the converted *Lio* the steam-operated cargo-winches and cargo-pumps and the starboard boiler will be retained. Certain steam-driven auxiliaries will be retained and relocated in a boiler-room built about the starboard boiler. All other machinery excepting, of course, the main propelling engine and generators will be electric motor-driven and will enable the ship to operate without steam while at sea. This combination requiring no steam at sea and retaining the present cargo-winches and cargo-pumps promises the most economical machinery arrangement under the circumstances.

The present steam-driven machinery and seating and piping for the same, except that required for the retained cargo-pumps and winches and boiler, will be removed, and converted or scrapped. The screen bulkhead between the present boiler and engine-room will be removed. Engine and boiler-room casings will be connected and extend to the casing top. Two heavy girders will be installed in the engine-room and riveted to the shell of the ship to carry the main Diesel engine. Seatings for the new auxiliary engine-room machinery will be built-up from the tank top, while those for the deck machinery will be altered to suit the new and converted machinery. This brief description of the necessary hull changes indicate the really small amount of alteration required to the ship's structure in making the conversion which is due almost entirely to the dimensions of the main propelling unit being suitable for installation in the present machinery space.

All the necessary service pumps will be attached to and driven by the main engine. A suitable three-stage air compressor is attached to the forward end of the engine, there are three scavenging-air pumps driven from the connecting-rods of the main power cylinders in the usual Bethlehem manner. The single-acting, plunger type fuel pumps are located in a single block on the top of the engine and are driven by the main cam-shaft, while the fuel-oil supply, lubricating oil, circulating-water, sanitary and bilge pumps have a common base bolted to the main engine on the port side at the after end and are driven from the main crank-shaft.

In addition to the pumps attached to the main engine the following electric motor driven engine room auxiliaries will be installed:

A Bethlehem-Weir upright-type circulating-water pump.
A Northern-type lubricating-oil pump.
A Northern-type fuel-oil supply pump.
A Bethlehem-Weir plunger-type fuel-oil transfer pump.
A Bethlehem-Weir centrex-type fire-and-bilge pump.
A Bethlehem-Weir plunger-type bilge pump.
A Bethlehem-Weir plunger-type sanitary-and-port circulating pump.
A centrifugal fresh-water pump.
A Bethlehem-Weir three-stage air-compressor with inter and after coolers.

Power to operate the electric driven auxiliaries will be furnished by three Leisner type Bethlehem-Trout oil-engine driven generating-sets which will be arranged for parallel operation and supply current to a suitable switchboard. A small emergency oil-engine driven generator and air-compressor set arranged for hand starting will also be installed.

Salt water supplied by either of the two circulating-water pumps will be used to cool the main and auxiliary engines and a forced-feed lubricating system containing two pumps, a suitable cooler, purifier and storage tanks will furnish these engines with lubricating oil.

The Bethlehem Shipbuilding Corporation, Ltd., will convert the present steam-driven, windlass, warping-winch and refrigerating machine to motor drive, and will install a new Bethlehem-Moore hydro-electric steering gear.

New tanks will be furnished for the following purposes:

Starting air.
Injection air.
Fuel-oil day tanks.
Lubricating-oil storage.
Lubricating-oil separating.
Lubricating-oil drain.

The work of converting the steamer *Lio* to a motorship and all the machinery installed will meet the requirements of the highest class of the American Bureau of Shipping, and the rules of the United States Steamboat Inspection Service. It is the desire of the General Petroleum Corporation to secure in the *Lio* the best possible motorship for their gasoline-carrying trade.

The First Important Cargo-Ship Conversions.

Conversion of large cargo and tank ships to Diesel power is by no means an American experiment or a new idea, and until recently we were just as far behind Europe in this respect as we were in taking up the 100% new motorship. In 1917 Nobels of Russia started to convert their vast fleet of nearly 1,000,000 tons of steamers to oil-engine drive, supplementing their existing Diesel craft. But, the first real conversion of ocean-going ships was that of the three 5,000 tons d.w. single-screw cargo steamships *Pangan, Bandon* and *Chumpon,* now the *Songvar, Songdal* and *Songvond,* built in England in 1909 and now Norwegian owed.

These three ships were equipped with six-cylinder 26⅜″ by 39⅜″ four-cycle, single-acting, crosshead type British-built Burmeister & Wain Diesel engines of 1,600 i.h.p. at 100 r.p.m., which gave a sea-speed of nine knots on eight tons of fuel per day. Of this fuel 68 percent was burned by the main engine and 32 percent by the donkey-boiler, all the engine-room auxiliaries being steam operated and required about 50 to 60 h.p. on an average. The deck machinery was also steam driven and required 2¾ tons per day of fuel in port when two donkey boilers were running.

By taking the fuel consumption for an entire voyage and including both sea and port consumptions, no less than 46% of the oil was burned under the boiler and only 54% by the main engine, because the time in port nearly approximated the time at sea. This did not always apply, but refers to voyages made by these vessels between Norway, Boston, New York, and South America.

During the war Norwegians purchased these ships from the East Asiatic Company, made an operating profit of $2,000,000 and then sold them to S. O. Stray & Co. at $240 per d.w. ton. They were operated for some years by this company, who we understand, recently sold them to another Norwegian shipowning company. Prior to the conversion the actual consumption of the 2,000 i.h.p. steam plant of these ships was 34 tons per day at sea.

Valuable details concerning two of these ships can be found in MOTORSHIP for February, 1921, and October and November, 1922. Shipowner contemplating retaining steam auxiliaries when converting a ship should first read these articles before forming a definite decision.

Financial Benefits Derived By Converting With Federal Funds

Comparison of Overhead charges with those of a New British-built Diesel-driven Cargo Motorship. Americans Benefit Over $1,000 *Annually on an* 8,800 *Ton Vessel.*

WHILE many shipowners have indicated keen interest and desire to benefit by the new Ship Conversion Act, a few others have displayed a critical attitude on the assumption that the advantages to be derived therefrom are insufficient to warrant tying-up part of their business under the Board's control and that they prefer to use their own funds for Government hull conversions. The latter situation, however, we believe has been caused by a non-understanding of what the Bill actually provides, aside from the economical advantages after the conversion has actually taken place. It also should be realized that the fund is available for converting existing privately-owned vessels, as well as vessels purchased from the Board at low cost. It also can be used for new motorship construction purposes by American shipowning companies.

About $42,000,000 is available to private American shipowners for these purposes, in addition to the sum of $25,000,000 which is being used by the Board for conversion of 50 ships aggregating about 500,000 tons for ultimate sale to shipowners. Use of this money, and the purchase of good hulls from the Board, means that American shipowners in a short time can own and be operating vessels of the most modern type virtually equal to those of foreign construction and at a slightly lower cost than new motorships can be built abroad, and with consequent lower overhead charges on the first cost.

A fixed sales price of $7 per d.w.c. ton has been set on a number of ships if purchased for conversion with the owner's own funds and not to be converted with money from the Board. In cases where fifty percent of the cost of conversion is borrowed from the Board at not under 4¼% the first cost of the hull will be a little higher.

For instance, a hull of 8,800 tons can be purchased and new 2,800 s.h.p. engine-room and deck machinery installed and the entire vessel given a thorough reconditioning for a total cost of $450,000 to $525,000 including the hul's, which will cost about $10 per ton, if part of the conversion money be borrowed from the Board. The hull must be paid for in cash. Costs of conversions will vary considerably and will largely depend upon the extent to which reconditioning and hull changes are carried out. We will assume an intermediate total cost of $487,500. Assuming, also, that an American shipowner borrows one-half of the conversion charges from the Board and borrows the balance from bankers at 5%, or if he has the cash charges himself with the interest, we get the following:

Cost of hull, $88,000 at 5%	$4,400
50% of conversion charges, $199,750 at 4¼%	8,489
50% of conversion charges, $199,750 at 5%	9,987
Annual overhead on investment	$22,876

Let us see how this compares with the position of British shipowners who are building new motorships at a much lower cost than new vessels can be constructed in the United States. They are borrowing money under conditions by which the principal and interest are both guaranteed to bankers by their Government under the Trade Facilities Act, and our information is that at least 4% interest is being paid. In Great Britain the first cost of a cargo motor ship of about 8,800 tons is reported to be approximately $600,000, although in some cases slightly lower. This means that their total annual overhead is $24,000, which gives Americans the benefit of at least $1,123 less overhead charge per annum on a converted Shipping Board vessel. Furthermore, we have the advantage of buying fuel-oil on the spot at the lowest price.

In the case of American shipowners borrowing money from the U. S. Government for converting existing steamships of their own fleet, the value of the old machinery computed at the time of scrapping may properly be deducted from the income tax returns of the year in which the change is made.

Structural Changes During Conversion Work

Circumstances Under Which Old Line and Propeller Shafting Can Be Retained

By EDWARD G. TUCK, *Chief Surveyor, American Bureau of Shipping*

THOSE interested in the conversion of steamships to motorships may find it useful to note the following facts regarding the principal necessary changes to hull and machinery to meet the classification requirements of the American Bureau of Shipping.

Regarding the hull, the double bottom ballast tanks and the peak tanks may be used to carry oil fuel without structural change, except where the height of the overflow is increased to meet the requirements for oil tanks, to such an extent that the tanks will not satisfactorily withstand a test head to that height, in which case some additional structural strength will be necessary. Ceiling or dunnage on tank tops and bulkheads in cargo spaces, to prevent possible oil seepage, or fumes from same from coming in contact with the cargo. Some additional pumping arrangements will have to be provided to satisfy classification requirements and the machinery foundations will have to be replaced by foundations suitable for the new machinery. It will probably be desirable to remove some bunker and fireroom bulkheads, or so reconstruct them as to secure satisfactory structural efficiency of the hull in that vicinity. Rearrangement of the pillars and girders in the machinery space and the providing of settling tanks may also be necessary.

In connection with the main engines it may be found advisable to retain the old line and propeller shafts, since by so doing no change in the stern tube and stern frame will be necessary. An idea of the power and size of main oil engines that will be suitable for the different sizes of shafts at present in the ships may be obtained from the following examples and formula, to wit:

A 2,800 i.h.p. standard reciprocating steam engine running at 90 r.p.m. requires a 13½ inch line shaft and a 15¼ inch propeller shaft; these shafts will be suitable for either a two- or four-cycle oil engine of about 2,550 s.h.p. running at 100 r.p.m.

A 1,400 i.h.p. standard reciprocating steam engine running at 100 r.p.m. requires a 10 inch line shaft and a 12 inch propeller shaft; these shafts will be suitable for an oil engine of about 1,300 s.h.p. running at 115 r.p.m.

A 2,500 s.h.p. steam turbine geared to turn the line shaft 90 r.p.m. requires a 12¾ inch line shaft and a 13½ inch propeller shaft; these shafts will be suitable for an oil engine of about 2,500 s.h.p. running at about 120 r.p.m.

The shaft or brake horsepower of oil engines suitable for other sizes of shafts may be approximated from the following formula:

$$\text{S.H.P.} = \frac{d^3 \times \text{R.P.M.}}{88},$$ where "d" equals the diameter of the line shaft in inches, and assuming that the oil engines are fitted with sufficient fly-wheel effect to keep the engine speed fluctuation down to about 3 per cent above the mean speed.

It will be noted from the foregoing that ships now fitted with steam engines can be readily converted into motorships of approximately the same speed and power without any change being made in the line and propellor shafts.

Electric Transmission Or Direct Drive For Ship Conversions

An Argument for Diesel-Electric Propulsion Based On a Comparison with a Direct-Drive Slow-Speed Diesel Propelling Equipment

By W. E. THAU and H. C. COLEMAN
Marine Engineers
Westinghouse Electric & Manufacturing Co.

WITH the economic necessity of the use of the Diesel engine for merchant-ship propulsion established, because of foreign competition, it is highly desirable to give careful consideration to the question of the most advantageous and satisfactory way of applying this type of engine. Exhaustive studies have been made of the problem with particular reference to the conversion of present Shipping Board steam-vessels to motorships, and it is the purpose of this article to bring to the attention of ship owners and operators and other interested parties, the results of this work and the conclusions reached.

Detailed comparisons are made of the two general methods of applying Diesels, i. e., using large slow-speed engines direct-connected to propeller shafts and using a number of smaller higher speed engines direct connected to direct current generators supplying power to a double-unit motor connected to the propeller shaft. In the Diesel-electric system the data has been prepared on the basis of using the voltage control or Ward Leonard control scheme. With this system, shunt machines are used and both motors and generators are separately excited, preferably from the same source. The motor fields are excited at constant potential, and always in the same direction. The excitation of the generator fields is varied to suit the motor speed and direction of rotation desired.

By varying the voltage applied to the armature terminals of a shunt motor, having a constant field excitation, the motor speed can be varied in direct proportion, both as regards speed value and speed direction; and since the voltage generated by a constant speed, separately excited, shunt wound generator is directly proportional to its field excitation (neglecting saturation), the motor speed is, in turn, proportional to the generator excitation.

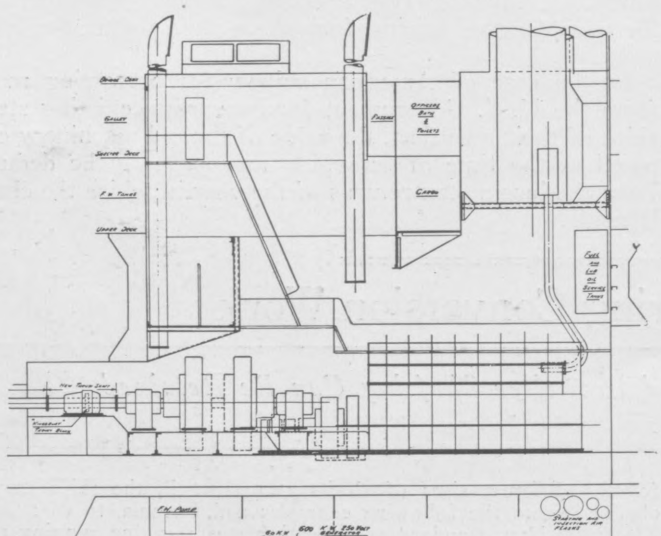
With such an arrangement, therefore, it is only required to vary the generator fields from full excitation in one direction to full excitation in the opposite direction, to cause the motor to maneuver from full speed ahead to full speed astern. To further simplify this method of control, all machines are connected in series. With the series connection, it is unnecessary to maintain like speeds on all the engines. Provided the generators are excited equal amounts and have identical performance, the only effect of difference in engine speeds is a proportional difference in the loads carried by the generators, and their driving engines. From an operating standpoint, therefore, the series arrangement is ideal, and permits by far the simplest system.

Since it is only necessary to handle the generator-field excitation currents for maneuvering the ship from full-speed ahead to full-speed astern, or holding any particular desired speed, the economy of this particular system is obvious for the reason that the generator-field excitation power does not exceed 1½% of the total output of the generator. Dealing with these small currents, the control is extremely simple and inexpensive. This simplicity has a further direct effect on the maintenance of the equipment.

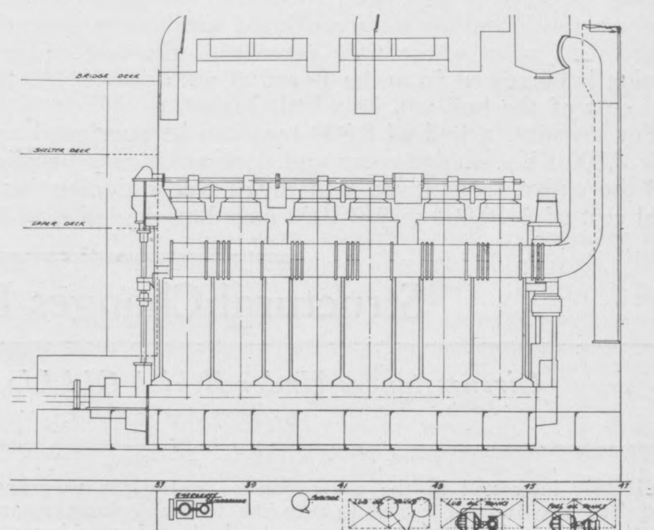
In comparing the two types of drives, the requirements may be enumerated as follows: Reliability, weight, space, installation, first costs, fuel consumption, and operating costs.

Reliability: Reliability should be the first consideration in selecting any propulsive equipment. Compared with single-screw direct Diesel drive, the Diesel electric drive has the following distinct advantages:

* Marine Engineers Westinghouse Electric & Manufacturing Co.

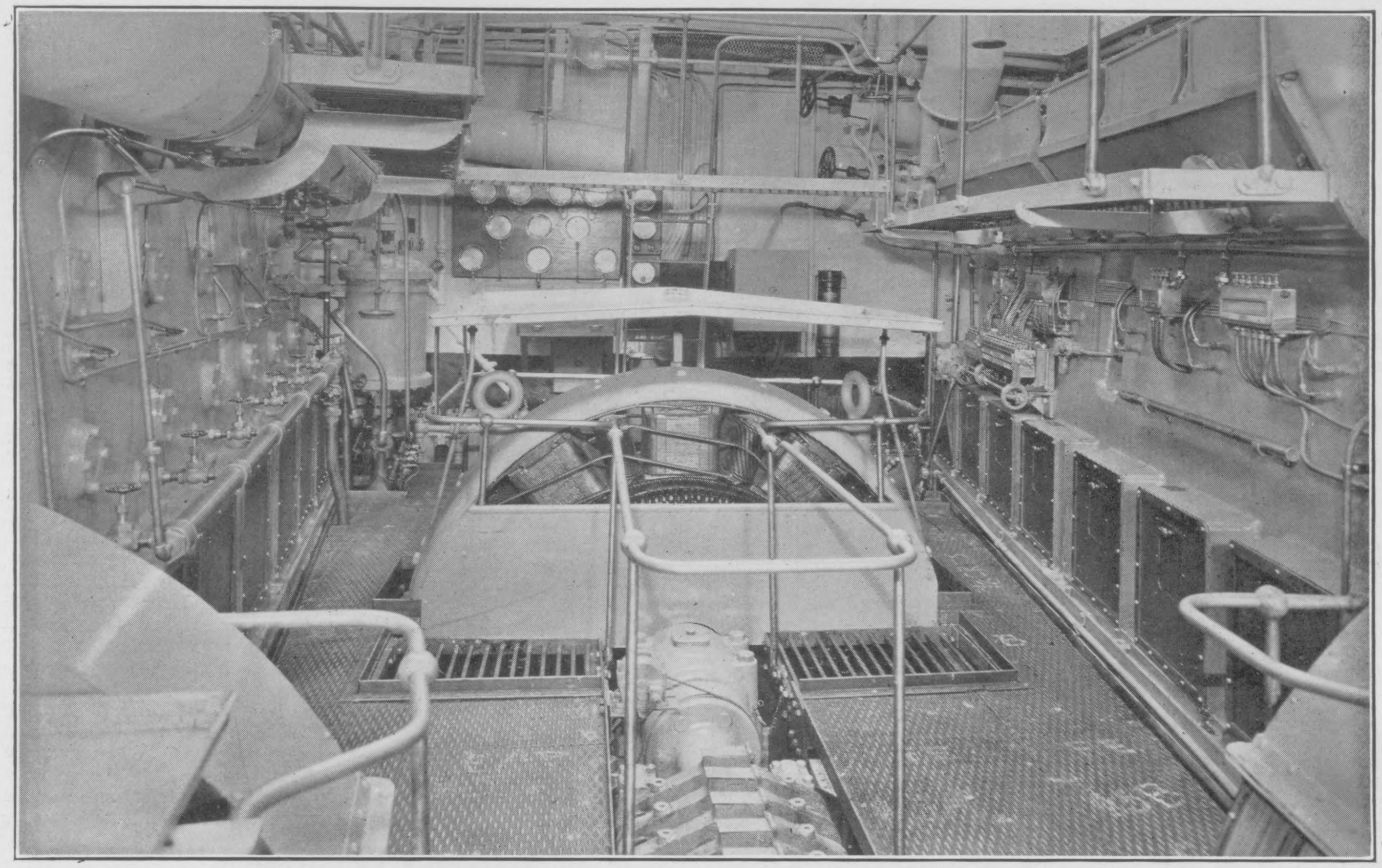


Proposed lay-out for Diesel-electric type of steamer conversion showing four 8-cylinder 850 b. h. p. at 250 r. p. m. Diesel engines connected to generators and furnishing current to a single slow-speed motor.



Typical lay-out of single-screw slow-speed 2,800 s. h. p. Diesel drive direct-connected to the propeller, together with arrangement of Diesel-electric auxiliaries the shaft power being the same as the adjacent electric drive.

Examples of Diesel-electric Drive Installations



Coastwise tanker with medium-speed Diesel-electric drive showing open type of propelling motor.

Crosshead type Diesel-electric drive showing enclosed propelling motor. The Diesel engine in the background is a McIntosh & Seymour crosshead design, while their trunk-piston units are shown in the upper illustration.

(a) A number of units provide reserve power in case of casualty to an engine. For example, in a four-engine installation, the following ship speeds may be maintained, based on the power varying as the cube of the speed:

4 engines	100%	ship speed
3 engines	91%	ship speed
2 engines	79%	ship speed
1 engine	64%	ship speed

The electrical system is such that full power may be obtained from each engine in operation.

(b) The smaller cylinders and absence of water or oil-cooled pistons and reversing gear is decidedly conducive to lower maintenance by virtue of the simplification of the engine and plant.

(c) Smaller and lighter parts greatly facilitate repairs. This feature, together with the flexibility resulting from the use of a number of engines, makes repairs at sea and routine inspection and overhaul possible while the vessel is under way. Also, the facility of correcting minor defects as soon as they develop, with comparatively negligible loss in ship speed, will reduce maintenance to a minimum and approach 100% plant operation. This also adds to the contented temperment of the engine room personnel.

(e) Perfect and instant control from the bridge eliminates all possibility of mistaken signals and thus safeguards the ship in restricted waters.

(f) The compressed air problem is reduced to its simplest terms since the engines operate at constant speed and in one direction at all times regardless of propeller maneuvers.

(g) The addition of electrical apparatus introduces no hazard for the reason that its thorough reliability is established beyond a doubt. The electrical system employed, as previously pointed out, is the simplest possible and easily understood. The motors and generators are simple and require very little attention. The accompanying illustrations show an open-type double-unit motor and a totally enclosed, forced-ventilated type, both built for Diesel-electric propulsion.

Weight: The difference in weight varies with the engines selected in both cases. An analysis of total machinery weights, including deck and engine-room machinery, foundations, ladders, gratings, structural work, etc., based on three types of direct-connected engines and three types of Diesel-electric drive engines suitable for delivering 2,650 to 2,800 shaft horsepower discloses an average weight difference of 116 long tons in favor of the Diesel-electric. In this analysis, the direct-connected engine speeds covered a range of 85 to 105 r.p.m., while the motors of the electric drive are designed for 90 r.p.m. (Some of the direct-connected engines which will undoubtedly be used in the conversion work are heavier than the average direct-connected engine used in this analysis.)

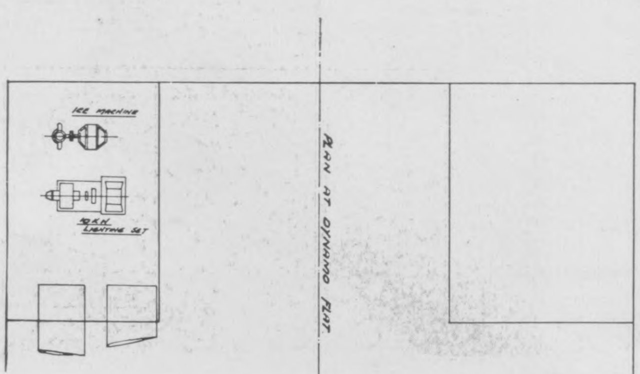
To evaluate the weight saving in the case of the Diesel-electric drive, it is fair to consider that one-half the difference would be used for additional cargo. This factor of one-half allows for the possibility of not being able to obtain the additional cargo on some trips and of carrying cargo on which a lower rate of freight is paid, on other trips. Assuming that the vessel travels 42,000 miles per year and that the freight rate is $5.00 per 1,000-ton miles, the additional yearly earning capacity of the Diesel electric ship over the direct-connected Diesel vessel is

$$\frac{116}{2} \times \frac{42{,}000}{1{,}000} \times \$5.00 = \$12{,}200$$

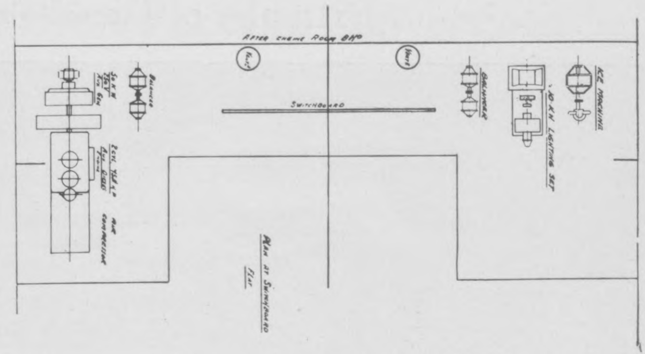
Conversely, if it is desired to consider a given cargo in both cases, slightly less power would be required for a given ship speed, in the case of the Diesel-electric vessel.

The advantage of being able to handle 116 tons additional peak cargo at certain times will be obvious to owners and operators.

Space: In comparing space requirements, the differences are found to vary considerably with the engines used. Owing to the lesser head-room required in the case of the Diesel-electric drive certain overhead space is available for cargo without changing the present arrangement of flats. This is plainly shown in the drawings given, which show engine-room layouts for Diesel-electric drive, using four engines. This layout shows that all the machinery may



Plan of dynamo flat of direct drive installation.



Plan of switchboard flat of electric drive installation.

be conveniently located in the space normally allowed for the steam propelling machinery. Another illustration shows an engine-room layout, using a direct-connected Diesel.

Installation: The average total installation costs including placing and aligning of machinery, wiring, piping, foundations and structural changes are in favor of the Diesel-electric by approximately 15%.

The Diesel-electric drive allows of better distribution of weight as the engines are entirely independent from the propeller shaft, and may be located so as to best suit the space and weight distribution requirements with minimum changes to the present structures. Also, another important advantage of the Diesel-electric drive is the fact that in no case need propeller shaft changes be made at present propeller speeds and 2,800 shaft horsepower, because of the constant torque exerted by the motor or, conversely, no reduction in power over the present power at present r.p.m. is necessary with the Diesel-electric. However, with the direct-connected Diesel, due to its varying or pulsating torque, in many cases either the present shafting will have to be replaced with larger, or the power at present r.p.m must be reduced. Or the speed at 2,800 shaft horsepower must be increased over the present value in order to come within the rules of the American Bureau of Shipping. Should the power or speed be changed it is quite likely that new propellers would have to be fitted, resulting in additional costs.

First Costs: An analysis of the total costs of conversion including machinery installation of both deck and engine-room foundations, etc., based on the average of acceptable direct-connected engines as compared with perfectly suitable and reliable Diesel-electric drive shows that the latter costs no more than, and in some cases less than, the direct drive, in instances where the present shafting does not have to be changed. Where shafts must be replaced because of direct drive, there is an additional cost for the direct drive of $30,000 or more. Where speeds are increased so as to bring the shaft requirements within the limits of the rules of the American Bureau of Shipping at 2,800 shaft horsepower, with direct-Diesel drive, new propellers at a cost of $8,000 to $10,000 are required.

While it is recognized that double-acting two-cycle engines will require shafting only slightly in excess of that for the constant-torque electric drive, it is nevertheless true that this type of engine cannot be considered as an established commercial development in the United States at the present writing. Furthermore, any advantages incident to this engine as a direct drive appliance will apply in like proportion to electric drive engines. The foregoing relates to average conditions; for local business reasons, isolated examples may be at variance to this analysis. However, such cases cannot be considered as representative of general market conditions.

Fuel Consumption: (a) At Sea: In regard to fuel consumption it is admitted that the fuel cost will be less for the direct drive than for the Diesel electric. However, a consideration of the actual amount of this difference will show that this is a greatly over-stated difference. Assuming that a ship travels 42,000 miles per year the difference in fuel cost would be as follows:

0.39 lb. oil per s.h.p. hour for direct-connected engine.

0.485 lb. oil per s.h.p. hour for Diesel-electric drive.

Because of the difference in propeller and operating efficiency due to:

(a) Constant torque of the Diesel-electric as compared with the cyclic variation in torque of the direct drive.

(b) Average difference in propeller speed.

(c) Percentage of operation at reduced power. (Diesel-electric can be operated at full-load unit fuel-rate at reduced speed whereas the economy of the direct drive decreases with reduced power.)

The Diesel-electric would not consume in excess of 20% more fuel than the direct drive. (4.5% allowed for (a), (b) and (c). Therefore, the next difference per s.h.p. hour (at sea) is 20%; or the Diesel-electric requires 20% or 0.078 lb. per s.h.p. hour additional fuel over that used by the direct drive. Then, assuming a ship speed of 12 miles per hour at full power, the additional fuel consumed per year by the Diesel electric is

$$\frac{42{,}000}{12} \times 0.078 \times 2{,}800 = 765{,}000 \text{ lbs.}$$

Using 340 lbs. of oil per barrel and assuming the cost of fuel oil as

$2.00 per barrel, the additional fuel cost (at sea) per year for the Diesel-electric is

$$\frac{765{,}000}{340} \times \$2.00 = \$4{,}500.00$$

which is in favor of direct drive.

(b) In Port: As will be noted from the Diesel-electric layouts, it is proposed to use one 50 k.w. auxiliary Diesel-generator set, which will be used when not handling cargo. One of the main engines will be used in part when handling cargo. For the direct drive, three 100 k.w. auxiliary generating-sets are required. The average port load will be about 300-engine b.h.p. when handling cargo and 40 b.h.p. when not. Comparing the engine unit fuel consumption, the large engine at 300 b.h.p. load will require about 0.55 lb. per b.h.p. hour while the smaller engine (150 b.h.p.—two or three in use simultaneously with direct drive) will consume about 0.48 lb. per b.h.p. hour, making a net difference of 0.07 lb. per b.h.p. hour.

Assuming 2,500 hours per year cargo load, we have,

$$\frac{2{,}500}{340} \times 0.07 \times 300 = 52{,}500 \text{ lbs.}$$ fuel oil additional per year for the large engine, which gives,

52,500 x $2.00 = $309.00 additional fuel cost per year for port consumption for the Diesel-electric, which favors the direct drive.

To offset the above, we have the lower rate of fuel for auxiliaries while at sea in that they are supplied from exciters driven by the main engines at a fuel rate of 0.42 lb. per engine b.h.p. hour, whereas, with the direct drive, the fuel rate of the 150 b.h.p. auxiliary engine at 45 b.h.p. will be about 0.53 lb. per b.h.p. hour. This gives 0.11 lb. per b.h.p. hour additional fuel required by the direct drive. Assuming 30 k.w. load (45 b.h.p.) at 3,500 hours sea time we have

$$\frac{45 \times 0.11 \times 3{,}500 \times \$2.00}{340} = \$102.00 \text{ per year}$$

additional for the direct drive, favoring Diesel-electric.

Operating costs: The study indicates that the personnel should be the same for both the direct-Diesel and Diesel-electric drives, particularly because single-screw ships are being considered.

Summarizing the other yearly operating costs, we have:

Favoring Diesel-Electric.		*Favoring Direct-Diesel.*	
$12,200.00	Additional cargo revenue.	$4,500.00	fuel saving at sea.
102.00	Auxiliary fuel saving at sea.	309.00	fuel saving in port.
$12,302.00	Total	$4,809.00	Total

Difference: $7,943.00 favoring Diesel-electric. The equivalent capitalization at 15% would be $50,000.00 which represents the additional amount that could be paid for Diesel-electric equipment to place it on the same basis with the direct-Diesel drive. However, the cost analysis shows that this amount would be an excessive difference when compared with the actual figures. All cost figures in this study are on the same basis and therefore the relative comparison is correct.

The above analysis is based on the ship having the same capacity of fuel-oil tanks for either type of drive. Since the Diesel-electric drive requires approximately 20% more fuel-oil than the direct-Diesel, the ship fitted with the former would have about 20% shorter radius of action for each fueling. However, if it is desired to compare the two drives on the basis of equal radius of action, the additional weight of fuel-oil carried by the Diesel-electric ship must be taken into account. The total additional fuel-oil per year for the electric drive including that for port as well as at sea is

$$765{,}000 + 52{,}500 - 17{,}300 = 800{,}200 \text{ lbs.} = 358 \text{ long tons.}$$

Based on ten voyages per year and on fueling per voyage, the Diesel-electric ship must carry 35.8 long tons more fuel-oil per voyage than the direct-Diesel ship. Subtracting this from the machinery weight saving, the revised additional yearly cargo revenue becomes $8,430 and the difference in yearly operation costs favoring the Diesel-electric is $3,723, which gives an equivalent capitalization of $24,800.

Auxiliaries: It is of course expected that all the vessels converted to motorships will be equipped with an all-electrical auxiliary system. The waste incident to donkey-boilers and steam auxiliaries has been recognized practically since the advent of the motorship and the use of electrical auxiliary machinery is considered almost as much an economic necessity as the Diesel engine for propulsion. The performance of electrical auxiliaries on motorships for the past 10 or 12 years has proven and thoroughly established their reliability for the service.

Conservatively speaking, deck auxiliaries require less than 1/10 as much fuel as steam machinery. Electrical engine-room auxiliaries also effect a considerable saving. Experience has shown that with properly designed and applied machinery, the maintenance cost has been practically negligible. As far as operation and performance are concerned, the inherent characteristics of the electrical machinery leave nothing to be desired. The extreme flexibility enables designs and arrangements to meet any conditions. The problem of installation is also made simpler with electrical auxiliaries.

Among numerous general advantages accruing from the use of electrical auxiliaries, we might mention

(a) Much quieter and infinitely cleaner ship.
(b) Machinery ready for use on instant notice.
(c) Any desired arrangement and location of control may be obtained.
(d) Performance may be easily checked and recorded with electrical instruments.
(e) Machinery is safer and more convenient to maintain.
(f) Improves living conditions on board ship.
(g) No damage to cargo as a result of leaky steam pipes.
(h) No trouble due to climatic conditions, such as frozen steam pipes.

In conclusion it is pointed out that those who are considering converting cargo ships would do an injustice to themselves by not seriously and conscientiously considering Diesel-electric drive and electric auxiliaries. Even placing the initial cost and the operating cost on a parity, the many intangible advantages of the Diesel-electric drive would more than warrant its installation.

Supplanting Steam Deck Auxiliaries With Diesel-Electric Units When Converting

Why it Will Eventually Pay to Discard the Old Deck Equipment and Install Modern Electrically-Operated Winches, Windlass and Steering-gear is Ably Discussed by P. E. Kriebel of the American Engineering Company in this Partially Technical Talk Directed to the Shipowner.

CONVERSION of ships from steam to motor drive is a big problem to be handled in a big way. Proper decision as to type, size, power, etc., of the driving element is admitted to be of greater importance than other considerations. But many things contribute to make reconditioning a success. If the conversion is to be a conversion, the thing to do is to convert in a big way. This means that all steam-driven units be placed in the discard and electric or electro-hydraulic power be substituted, not only in the engine-room but on the deck and at the rudder post.

Those who, in a broad-minded manner, have already done this thing are the strongest advocates of such complete conversion, and are ready and willing voluntarily to proclaim the splendid results. An array of facts and figures are available that show the true saving of fuel consumed on ships that at one time had steam auxiliaries and now have electric. No more ideal chance to get correct data is imaginable. These figures do not admit of any possible doubt. On cargo hoists this is particularly noticeable and runs into a considerable item when figured over a space of time.

Progress toward the adoption of the use of electricity on ship board has been a long, hard, uphill fight, Today, a high plane of development has been reached fundamentally and a proof been given of such a degree of excellency in operation, that it is hard to conceive of any possible future improvement, except refinements of a minor nature from time to time.

Let us consider the cargo hoist. No piece of apparatus aboard ship gets worse or even equal abuse. Exposed to the elements, frequently neglected as to lubrication and repair, it is expected on reaching port to be ready instantly for a long hard drill at the hands of all sorts of humanity. And it must be remembered, delays or breakdowns are costly.

Long steam lines, whose leaks are creators of much damage at times, through deck weaving and other causes, freezing cylinders, valves that soon blow through in service, and many other elements, combine to make the steam hoist costly to operate. The electric hoist as built today by such manufacturers as have been far sighted enough to develop it to a high state of perfection, does away with all these objectionable features.

The steam hoist has a degree of flexibility of control which appears to be unapproachable compared with the rigid characteristics of the electric motor. But the direct current motor with its capacity

for overload and its newer types of control as now applied, gives a flexibility with varying loads and speeds that is surprising.

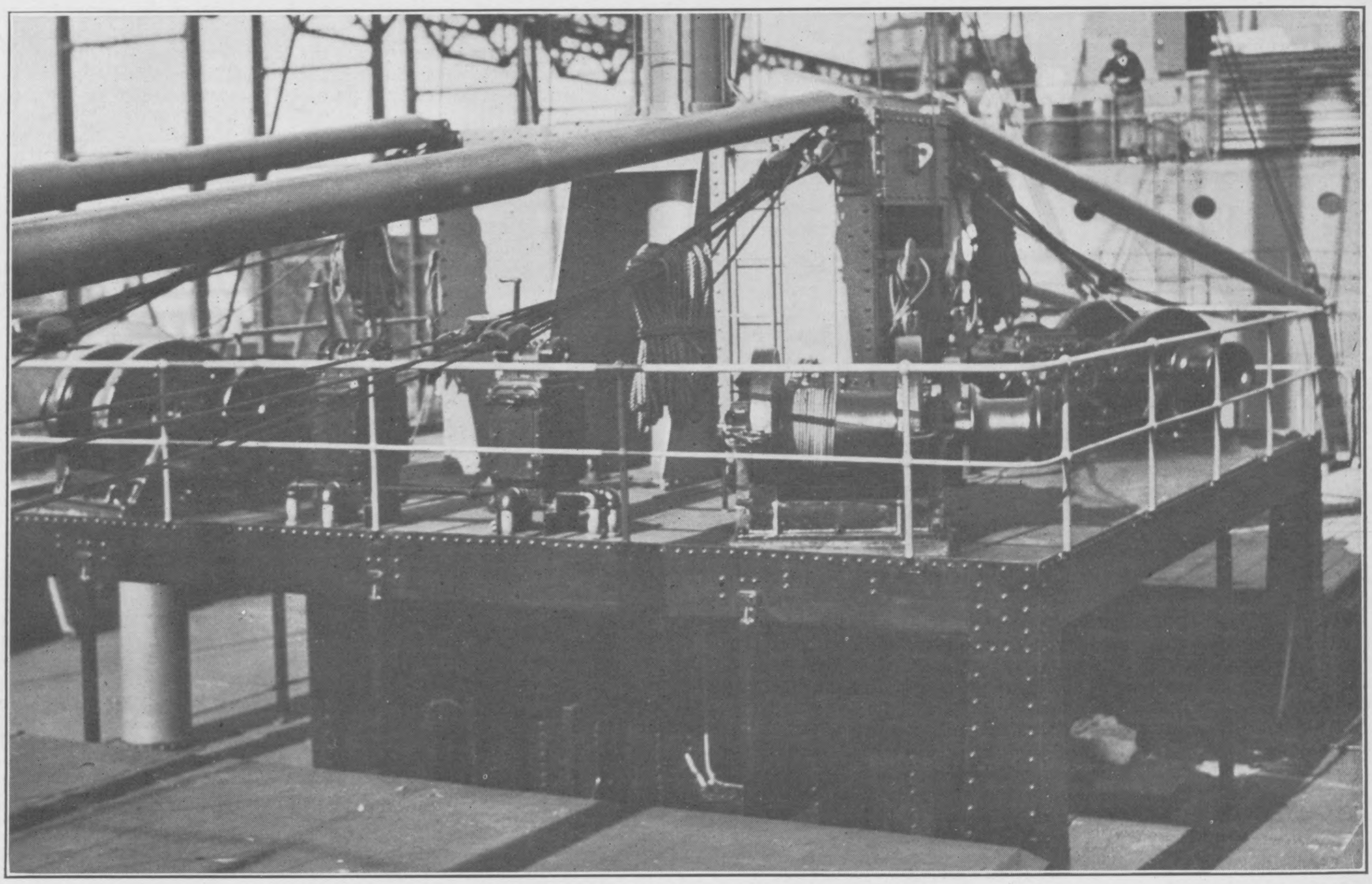
Very high speeds for light loads are obtainable, and heavy, even excessively heavy loads, considerably beyond the normal rated capacity of the motor, can be lifted at slow speed—never mind how slow—they can be lifted. The steam hoist would stall—there is no overload capacity.

Reliable hoist builders in rating capacities are honest enough not to take this feature into consideration in their promises of performance. When they say their product will lift 4,000 pounds at 200 feet per minute, it is based on normal rating of the motor. All the rest is reserve. Surely this is a feature that should appeal to those who many times have had to stop to reeve long lines of rope through purchase blocks because there was not quite enough "heft" available.

The electric hoist is always instantly ready. When not running, it consumes nothing; when running, it uses what it needs and no more, and where provision is made for dynamic breaking, it pays back juice in lowering. No such thing can be said of the steam hoist. Moreover, the entire machine will stand submersion between ports and will actually run under water. It is absolutely watertight.

quite a different operation to turn on steam, warm up, drain cylinders, etc., than to throw a switch and open a control. Again, the steam line nuisance is eliminated, and when boilers are aft, this means for the entire length of the vessel. In cold weather, with pipes on deck, ship engineers know what is involved. If it is endeavored to keep the pipes warm, it is a woeful waste of fuel; if not, there is freezing to contend with.

By far the best procedure is to install an entirely new windlass. It may be a minor consideration, but the appearance of the converted steam windlass is incongruous. It is practically impossible to delete the steam features such as guides, etc., without entire new housings, which means complete dismantling and reassembly. Moreover, the bedplate for the motor and its brake and gearing must be of necessity, a separate casting, bolted to the main bedplate when and where possible. It has been done, notably on two converted Board vessels, and the operation of each has proven highly successful. Nevertheless, in order to gear into some makes of spur geared windlass used on Shipping Board vessels, the only point of attachment possible for the motor and brake is in a decidedly wrong location—forward, cramped into a space between the anchor chains, in



Mounting of cargo winches on island platforms as illustrated is rendered possible by the use of electric power for this machinery. This facilitates cargo handling and enables big deck loads of lumber to be carried.

With the use of electrified auxiliaries, boilers are dispensed with, excepting possibly a small "donkey" for heating purposes. One or possibly two boilers must be retained if steam auxiliaries are not dispensed with, and one entire boiler run continuously at sea for the sole use of the steering gear.

When electric hoists are substituted, it is well to add that the expensive need of running one or possibly both of these boilers in port is dispensed with. If the current characteristics on shore are the same as on the vessel, the ship's line can be plugged in and the ship's generators remain idle. Where privately owned lines have fixed ports of call, permanent provision can be made for this, the advantage of which is immediately apparent.

The point of operation, instead of being fixed at the throttle, may be located at points at or near the hatch, reducing to an absolute minimum danger of accident, or damage to cargo. This speeds up the work considerably, since it is obvious that the operator can accomplish more in less time when he can see what he is doing.

What is true of the hoist is also true of the windlass, which inherently is a glorified hoist. Frank to say, there is not the saving in dollars and cents per year, but this is only on account of the intermittent duty. Proportionately, the savings are identical.

But—the feature of absolute dependability, the assurance that the windlass stands ready for instant call to duty, far outweighs the cost any change-over or substitution entails. Many times it is the most exposed position imaginable. In spite of this, it may be an emergency with serious consequences ahead, in which event it is

the most exposed position imaginable. In spite of this, it may be said that it is possible to have the location of control in a convenient position.

Consider the warping capstan. If the capstan is rated at normal motor horsepower and not at its maximum output, here again we have that altogether desirable reserve, an advantage not to be passed over lightly. Exceptional tide rips, heavy winds or poor judgment in berthing may place the ship in such position that short hawser leverage must at times be applied most strenuously to hold fast and swing—gradually perhaps—but in any event, swing. This calls for a pull far in excess of any calculated in the specification for the machine, and the reserve of the electric capstan makes it the only type that can arise to such emergency.

Where the engines are between decks, conversion is simple and appearance not affected since it only means discarding the engine and substituting a motor-driven worm and worm wheel, self contained. But where the dock type with engines in the capstan base is to be converted, difficulties will be encountered. A new capstan is then desirable. In some designs, the cramped space in the casing precludes attachment of any bevel gearing to the existing crank shaft—chain and sprocket must be used. Gearing the motor to one end of the crank shaft is possible, but any of these arrangements, aside from spreading over considerable deck space, is a mechanical abortion.

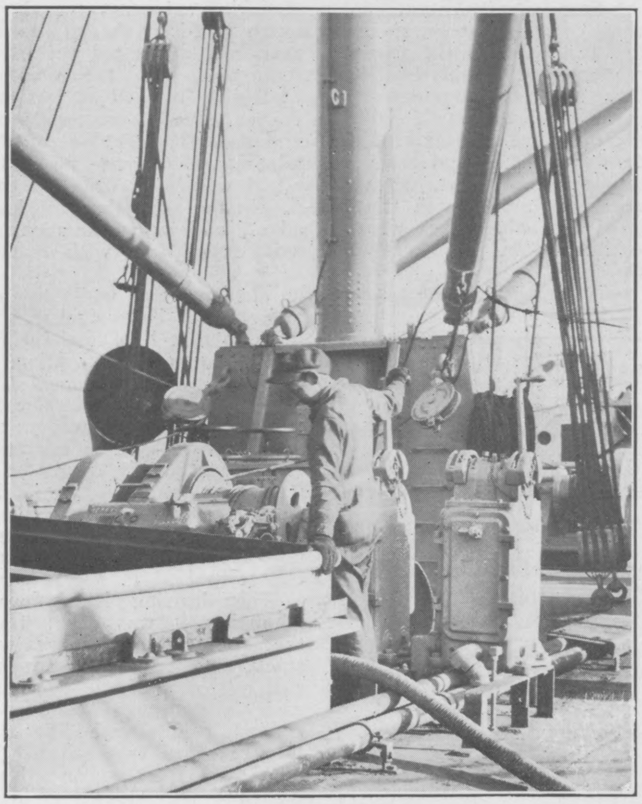
With regard to the steering gear, we believe, and it is almost universally admitted, that the retention of the steam gear should not be considered for a moment. The amazingly high economic saving

of the electro-hydraulic steerer makes this machine pay for itself quite rapidly.

With manual operation of the wheel, the steering gear is rarely idle at sea. And continuous starting and stopping eats fuel rapidly. This is true not only of the steam gear, but of any type of mechanical-electrical steerer with its high inrush of current at each cycle of operation. In addition, there is the continual snapping in and out of contactors, with possibility of burning.

On the other hand, the electro-hydraulic steerer has a motor constant running in one direction from time of departure until arrival. The control of the flow of the hydraulic medium is at the variable-stroke pump, which is driven by the motor. It is capable of building up great pressures, as required, while using a much smaller electrical outfit. For instance with efficiency at the crank-shaft of 57%, a 9" x 9" steam engine is delivering 88 b.h.p. A mechanical-electrical steerer to steer a vessel requiring this size steam steerer would need a 50 b.h.p. motor, whereas an electro-hydraulic steerer for the same vessel only takes 15 b.h.p.

It may be argued that a 15 b.h.p. motor constantly running eats up a lot of current, but it should be remembered that this is its maximum capacity calculated to meet the extreme condition; i.e., going to hardover at full speed, or toward midship backing. In the cruising angles, current consumption is a surprisingly small percentage of maximum motor torque. As a matter of fact, actual readings taken show it to be about 33% at 15° helm, gradually reducing to practically zero at 'midship. When the rudder is at rest, the motor is only idling the pump and therefore using but a fraction of a horsepower. The fuel consumption of an oil-engine drive for the generator is remarkably small, and the current usually is a part of the out-put of one of the auxiliary sets in the engine-room.



Control for electrical winches can be carried to a point alongside the hatch, enabling the operator to look into the hold. Note that the operator's hand is on the control lever.

When it comes to lubrication, the average steering gear is grossly neglected. This is hard on any mechanism and particularly so on a steam engine with many rapidly moving parts. The fluid medium of the hydraulic gear in question is oil, so the pump and all internal inaccessible parts are self lubricating. The grease cups on several pins in the follow up levers and the motor shaft are all that need attention. The oil used in the system is a light lubricating motor oil having a freezing point of 5° Fahr.

There is one thing that is the cause of a prolific amount of repair business for the steam gear manufacturer,—the fact that the sea will cut up once in awhile and the rudder be subjected to undue strains, and worst of all, sudden heavy shocks.

Practically all of the Board's steamships are equipped with the screw-gear type of steerer or the steam tiller. On the former, no provision is made for taking care of shock—it is absolutely rigid. On the latter, there is usually furnished a form of adjustable slip friction, but it has been found in actual service these are seldom adjusted at all and are usually bolted down tight. Differences in design, or of friction material, or in machining, make it only possible to adjust the slip friction by "feel." After many unsuccessful attempts to get it just right, the ship's engineer is generally tempted to "bolt her down and let her go." So here again we have in effect the rigid gear.

Possibility of damage to the electro-hydraulic steerer is entirely eliminated by installing in the hydraulic line, a by-pass valve, adjustable by springs to a positive predetermined pressure. This automatically allows the liquid to flow from one cylinder to the other whenever this pressure is exceeded. The followup mechanism brings the rudder back instantly the overload is released. There is no inclination to tamper with this relief adjustment because once made, it is set for all time—and you know exactly what you have, to the pound.

The gear is flexible as to installation, the rams may be athwartship or duplex, fore and aft. With the latter, they may be located at the crosshead or forward of it and connected by links. The pump and motor may be located at any convenient point not out of reach of a followup rod.

There may be some who would ask whether it has passed the experimental stage. In answer to this, attention is called to many similarly equipped foreign ships that ante-date our motorships, the history of whose performane has been carefully scrutinized by many American marine experts. The records show practically perfect operation at all times. The *William Penn, Californian, Missourian, Seekonk* and *Challenger* are so equipped. There are some steamships now laid up belonging to the Shipping Board that also have this gear. Incidentally, it is the only type of gear that will steer our larger battleships and airplane carriers.

Just two more items of note—first, on all electric auxiliaries now in service on existing American motorships, the owners have been agreeably surprised at the ridiculously small amount of repair expense. It is such an outstanding fact that they have gone out of their way to tell of it.

Secondly—you can walk away from electric machinery and leave it "as is" indefinitely. And when you come back it is all set for its duty without fuss or preparation. If the interval of idleness is of any great length, all marine engineers know what expensive, painstaking operations must be gone through with steam machinery in a similar event. This should be kept in mind if considering favorably the retention of steam auxiliaries on the ships about to be converted. They have been idle or years, and putting their winches, capstans, etc., back into condition, not to mention steam lines, valves, boilers, condensers, etc., will be quite some task. When issuing orders for a ship's conversion, there are only four words to be included in the instructions,—"and electrify the auxiliaries."

Conversion of Our Coastwise Steamers

There is still a large proportion of our coastwise shipping interests not yet properly impressed with the economies of oil-engine propulsion for cargo and passenger ships for their particular services, and the task of converting many of these old steam men is even more formidable than the task of planting the Diesel idea into the minds of shipowners whose vessels are engaged on foreign routes. Protected by the Panama Canal Treaty our coastwise shipping has no competition other than within itself, and the various services are fairly well defined and divided among the different domestic companies. They are not faced with the problem of seeing foreign ships coming into our harbors, nor at the docks, and take away American products as cargoes under their very noses due to the lower cost of operation and to the efficiencies of more modern types of vessels. Nevertheless, oil-engine drive is making positive, even if slow headway in coastwise traffic and the successful results of motor craft already in service are not likely to be thrown lightly to one side. Those coastwise shipowners who at the present time show practically no interest in this type of power will be obliged, by the very law of economics, to give the question far deeper consideration in the immediate future.

Engineers for the Shipping Board's Motorship Fleet

At a meeting of the fuel conservation committee of the Emergency Fleet Corporation at 45 Broadway on September 11th, a resolution was adopted looking to the giving of preference to engineers on the honor roll of the Fleet Corporation when selections are made for the crews of the new Diesel-driven ships which the Board is to convert from steam power. The resolution follows:

"That in order that there may be a real incentive for engineers in the existing fleet of the Shipping Board to bring their vessels up to the maximum efficiency and in this way have their names entered upon the semi-annual honor roll issued by the Fuel Conservation Committee, a preference should be given to the applications of those chief engineers whose names appear upon these honor rolls when the time arrives for recruiting and training an engineer force for the ships which are to be converted to Diesel drive.

"That for other engineer positions on these motorships below the rating of chief, preference will be given to those engineers of the existing Shipping Board fleet who have demonstrated by their efficiency on ships the chief engineer of which has appeared on honor roll, their fitness for handling an engineer's position on one of those Diesel drive ships."

Boiler-Oil Or Diesel-Oil Fuels for Motorships.

Best Results for Oil-Engined Vessels, Even Superior to Lighter Diesel Fuels, Can Be Secured from Centrifuged Fuels of 20 to 22 Beaumé. Heavy Boiler-Oils Can Be Used Satisfactorily If Heated and Centrifuged by a System Costing About 1 Per Cent of Total Machinery Installation.

By LAWRENCE B. JACKSON, M.E.*

IN discussing the subject of fuels for ships converted to Diesel power we must not consider the engineering and operating economies in the abstract, but must consider concrete examples, or else the discussion will be of no value. While it is an established fact that some motorships in certain trades can operate satisfactorily on boiler fuel, it is just as certain that in other cases the use of the lighter grade now marketed under the name of Diesel fuel will be advantageous from an economic aspect.

Before discussing the subject further it should be understood that by "boiler-fuel" we refer to an oil of from 14° to 16° Beaumé, and that the designation "Diesel-fuel" refers to an oil of 24° to 28° Beaumé. In both cases the viscosity, moisture, sulphur and residue will vary according to the field from which the original crude oil was obtained.

An ocean-going motorship to operate successfully must be able to compete with a steamer in *all* phases. Therefore, if the motorships' trade route necessitates calls at ports where only boiler-fuel is obtainable—or where the difference in price between it and Diesel-oil is considerable—it is essential that the engines work satisfactorily on this grade of fuel, irrespective of price of various grades in other ports. To overcome this by carrying more bunkers of a different grade is not a satisfactory solution in that every ton of excess fuel carried shuts out a ton of cargo, and the high initial cost of the motorship is only warranted by the greater cargo capacity and fuel-consumption economy.

In determining whether or not it is advisable to use boiler fuel we must know, (1) the size and type of engines, (2) size of vessel, (3) nature of cargo, (4) ports between which vessel trades, (5) grades and prices available at the ports, (6) freight rates on cargoes between various ports, (7) distance between ports, and total length of voyage.

With this information at hand it is a relatively simple matter to figure out in dollars and cents not only what reductions can be made in fuel bills, but also quantities of bunkers advisable to take on at various ports. The saving effected in fuel bills, where size and type of engine permit use of boiler fuel, *is clear gain* and will *not be offset by increased maintenance costs.*

It is the writer's personal opinion that any good Diesel engine of not under 100 b.h.p. per cylinder and not turning above 160 r.p.m. can, or can easily be made to, operate satisfactorily on boiler-fuel. The most difficult case is the low-powered, high-speed trunk-piston engine; whereas when we come to engines of larger horsepower with water-cooled, crosshead-guided pistons and turning at less than 120 r.p.m. the difficulties are practically eliminated. While an engine that is so constructed as to use boiler-fuel satisfactorily will operate equally well on Diesel-fuel the reverse is not necessarily the case.

A well-designed and properly constructed crosshead engine, however, should be able to operate on boiler-fuel whether or not owners desire the same at the time of construction, and the day is not far distant when owners will specify that engine manufacturers shall guarantee the same.

Many articles and letters have been published opposing the use of boiler-fuel,—particularly in foreign magazines—in which were recited many difficulties that would be sure to be encountered. The writer—who has had not a little experience with such fuels—feels that in many cases the difficulties enumerated were theoretical deductions and not actual experiences. It could only be expected that some difficulties would be encountered, no new development has been effected without the overcoming of obstacles. The actual difficulties encountered were not very serious nor very difficult to overcome, and many of the professed difficulties failed to materialize.

* Member, A. S. M. E.; Soc. N. A. & M. E.; D. E. U. Assoc. (Engl.)

WHAT FUEL SHALL MY CONVERTED SHIP BURN?

THIS important question, which is asked by every shipowner figuring on converting a steamer, is answered in a practical way on this page by an engineer experienced in the operation of American motorships which for years have been running on the three grades of fuel-oils discussed.

He points out that slow-speed Diesel engines can satisfactorily burn heavy boiler-fuel without undue cylinder wear or increased maintenance charges, particularly if equipped with exhaust-heated centrifuge devices at a comparatively small initial installation cost, despite reports to the contrary.

While the best operating results can be secured from 20 to 22 Beaumé oils, a boiler-fuel heating and centrifuging equipment for heavier oils should form part of the machinery installation of every ship conversion.

The Editor.

One of the most frequently mentioned bug-bears was high sulphur content and moisture. After continuous tests at sea on two Diesel engines in a ship for a period of thirteen months the writer was unable to find any indication that the sulphur content had any effect whatever, notwithstanding that in some cases the sulphur ran as high as 4.38%. The moisture was easily eliminated by settling, and at temperatures of below 165° Fahr.

In starting these tests no changes were made in the engines, a fuel-oil heating system was installed and vessel went into service. This heating system was simplicity itself and gave perfect satisfaction It consisted of pipe coils in the silencer through which a pump circulated fresh water. The hot water (210° F.) from expansion tank above silencers was pumped through coils in the service and bunker tanks. This system is still in use and no repairs of any kind have been made since original installation three years ago. No difficulty was experienced in securing a viscosity of boiler-fuel equivalent to that of Diesel fuel.

The first difficulty encountered was sticking exhaust valves due to burning of stems at lower end. Rough cast-iron shroud castings were furnished and the engineers machined and fitted them, and permanently ended this trouble. At the same time it was noticed that the exhaust valves were not standing up as well as formerly. Experiments were made with valves of different materials and finally nichrome (an alloy of the stainless steel order) valves were made standard. Actual usage showed that valves made up of this material would outlast, when boiler-fuel was used, ordinary cast-iron valves running with Diesel fuel. At the same time the lower ends of the valve cages were turned off and renewable nichrome seats fitted. No further trouble was experienced with exhaust valves.

From the start of the tests it was apparent that while the viscosity of the boiler-fuel was the same as that of Diesel-fuel the rate of flame propagation, or combustion was considerably slower. This was noticeable, but not a source of worry and caused no trouble in operating. It was practically overcome by increasing compression 15 lbs. per sq. in., by advancing fuel injection 2° and by increasing the circulating-water discharge to 125° F.

When drawing pistons for examination it was often found that one or two top rings were stuck. Experiments were carried out on a couple of pistons using a two-piece "leak-proof" ring and results were so satisfactory that this type of ring has been since installed on all pistons and the sticking of rings, irrespective of fuel used, is of very rare occurrence.

During all these tests no attempt was made to secure an oil free from sulphur, moisture or sediment, and the oil was not centrifuged to remove. The installation was made at time of Lloyd's machinery survey after which the vessel resumed regular service and all alterations were gradually made by crew without delaying vessel. Had the advantages of a centrifugal-purifier been realized at the start, or had time permitted the installation at a later date, the results would have been even more satisfactory.

After running continuously for thirteen months a most careful examination revealed that the only noticeable effect of using this grade of fuel was a slightly increased wear at upper end of the cylinder liner. By carefully determining the wear for given periods using both grades of fuel we *estimated* the life of liners would be reduced, *in this particular case*, about 30% by continuously using boiler-fuel. After the vessel had been in service for four years careful measurements of liners indicated that we could expect at least four years' more service from original liners. The cost of new liners after eight years is not a great item of depreciation.

Months of operating on a grade of fuel of from 20° to 22° Beaumé, without heating the fuel have clearly demonstrated that

this grade of oil, in these engines, is superior to grades of from 28° to 32° Beaumé (so called Diesel-fuel) as well as being lower priced. Incidentally a barrel of boiler-fuel contains approximately 85,000 b.t.u. more than a barrel of Diesel fuel, so is doubly economical.

It has been claimed that the difficulty in pumping boiler-fuel is considerable. This claim is based on impressions not upon experience. It should be remembered that the motorship uses only approximately one-third the fuel of a comparable steamer, thus a high rate of transfer is unnecessary, and with a long-stroke, slow-speed, large valved pump, with the tanks heated not above 80° F. no difficulty will be experienced and the necessary heat can be obtained from the exhaust gases.

During the last year or so a considerable number of experiments have been made by centrifugal-purifier manufacturers in conjunction with oil-engine builders and shipowners. With a centrifuge treatment of different grades of fuel-oils including boiler-fuels of 14° to 18° Beaumé the results appear to warrant the installation of such a device in every motorship. Good results can be obtained by heating heavy oil to 140° F. and excellent results at 160°. But, unless the device is gas-proof care should be taken to make certain that the flashpoint of the oil is above the temperature to which the oil is heated to avoid danger of combustion. Many of the Mexican boiler-oils, however, have a flashpoint of not under 180° F.

Assuming that a shipowner has a freight steamer of 15,000 tons loaded displacement being converted to a single-screw Diesel engine of 3,000 shaft horsepower turning at 90 r.p.m. (or less) and that this vessel is to trade between U. S. A. North Atlantic ports and ports in the British Isles, and will carry a general cargo. The cost of installing a fuel-heating system using exhaust-gases as source of heat and including in the system a means of centrifuging the oil in such a vessel will cost approximately 1% of the machinery installation cost. The difference in fuel bills will pay for the installation in less than a year's time, and *maintenance costs will not be increased,* furthermore, reliability and maneuvering capabilities will be in no way impaired.

Converting Lake-Type Cargo Carriers

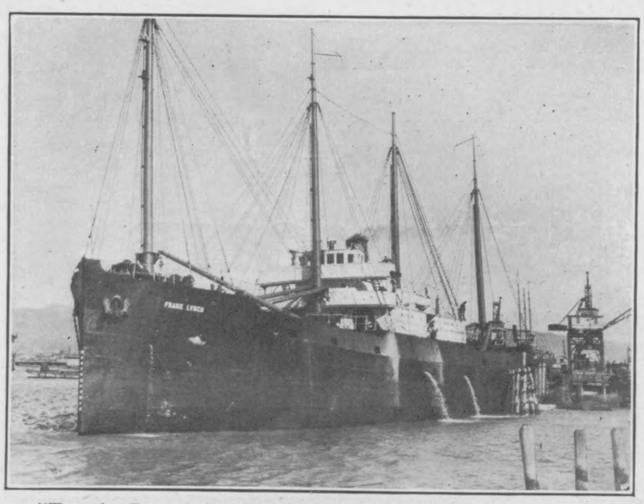
With the 2,992 Tons d. w. Shipping Board Vessel "Frank Lynch" ex-"Lake Sunapee," Steam Auxiliaries Were Retained Both in the Engine-Room and on Deck; But Exhaust-Gases from the Main Diesel Engine Are Utilized to Operate the Steering-Gear, with Augmentation When Necessary from an Oil-Firing Apparatus.

In reviewing the various steamer conversions that have been made, it is extremely interesting to note the great variety of installations that have been carried out. Many different ideas expressed by shipbuilders, owners and naval-architects are responsible for these varieties of installations. In most cases the main object in mind has been to effect motorship conversions with a minimum of first cost. This tendency has resulted in a few conversions in which the greater portion of the ships' auxiliaries are steam driven, using the old equipment for this purpose.

The steamship *Lake Sunapee*—a Shipping Board vessel, built in 1918 by the Toledo Shipbuilding Company of Toledo, Ohio, was converted into the motorship *Frank Lynch* the early part of last year on the Pacific Coast. This conversion took place at the yards of the Union Construction Company, Oakland, Calif. The vessel is owned by W. J. Gray & Co., San Francisco, and is used in the coastal lumber business. She is a very successful ship in this business and we understand has proven satisfactory in service to her owners since her commission in March, 1923. As a steamer, the vessel was employed on the Great Lakes, but after her purchase by the Gray interests, she was brought to San Francisco under steam power and then converted to Diesel propulsion.

Changes made to the hull include alteration to the stern frame, lowering the propeller-shaft, reinforcing the double bottom, installation of the Diesel-engine seating, and cutting-out the fire-room bulkhead. The bulkhead separating the boiler-room from the engine-room was removed and an I-beam girder installed over the engine to stiffen the hull. This conversion did not effect any change in machinery space. As a steamer the boiler-room and engine-room required a total length of forty-two feet. The Diesel machinery occupies the same space length.

To facilitate the rapid movement of lumber, four new steel masts were fitted with extra long booms as is required in the lumber trade. Also special steam winches were installed.



"Frank Lynch," "Ex-Lake Sunapee"-built on the Great Lakes in 1918 and converted to twin-screw Diesel power on the Pacific Coast.

The general characteristics of the motorship *Frank Lynch* are as follows:

Displacement, *loaded*	4,500 tons
Displacement, *light*	1,500 tons
Deadweight capacity	2,992 tons
Capacity of hold and 'tween decks	1,750,000 ft. lumber
Capacity of holds, *grain*	127,949 cu. ft.
Capacity of fuel bunkers, *double-bottoms*	522 tons
Fresh water capacity	115 tons
Length *o.a.*	261′ 0″
Length *b.p.*	251′ 0″
Breadth *md.*	43′ 6″
Depth, *md.*	21′ 0″
Draft, *mean loaded*	18′ 8″
Classification, *American Bureau*	100 A1

The power of this ship originally was a triple-expansion steam engine of 1,250 i.h.p. (1,000 s.h.p.) at 85 r.p.m. and two Scotch boilers, giving her a speed of about 9½ knots under favorable conditions. This installation was replaced by one six-cylinder, four-cycle, crosshead-type Pacific-Werkspoor Diesel engine of 1,150 i.h.p. (850 shaft h.p.) at 135 r.p.m., or of 48 r.p.m. higher speed.

Arrangements were made to use the same propeller-shafting and bearings; but, due to the fact that the new machinery, being of less power and higher speed, naturally required a smaller propeller, and because the motorship is used on the Pacific Coast and sometimes returns to her home port empty against heavy northwest winds and seas, it was found advisable to immerse the propeller two feet lower. An excellent job was obtained in lowering the boss on the stern frame. This was accomplished by cutting the stern frame just above and below the boss and Thermit, welding the lower boss in the stern frame. The wisdom of this procedure has been borne out in practice.

Some comparative figures on her operating data will be of interest.

M. S. FRANK LYNCH, ex S. S. LAKE SUNAPEE

	As a Motorship	As a Steamer
Cruising radius	20,000 naut. miles	3,000 naut. miles
Power, *shaft*	850 s.h.p.	1,000 s.h.p.
Power, *indicated*	1,000 i.h.p	1,250 i.h.p.
Engine and propeller speeds	135 r.p.m.	85 r.p.m.
Anticipated trial speed	8 knots	10.2 knots
Actual speed, *loaded*	7.8 knots	9.5 knots
Propeller diameter and pitch	10′ 6″ x 8′ 3″	14′ 6″ x 13′ 6″
Propeller area, *projected*	43 sq. ft.	....
Fuel consumption *per day at sea*	5 tons oil	20 tons coal
Lubricating oil consumption *per day*	12 gals.	7 gals.
Engine room and boiler staff	7 men	16 men
Fuel consumption *per day in port*	2¼ tons	4 tons
Length of machinery space	42 ft.	42 ft.
Donkey-boiler heating surface	1,400 sq. ft.	....
Cylinder bore and stroke	6 x 20½″ x 35½″	3 x 20½″ x 33″ x 54″ x 40″

In order that the auxiliaries required at sea, namely the steering-engine, the lighting-dynamo engine and the refrigerator machinery be supplied with steam, a branch was taken from the exhaust-pipe of the main Diesel engine and the hot gases allowed to enter the boiler fire-box to raise the required steam pressure. Under certain conditions it was found that gases would not supply sufficient heat to maintain the pressure required and a little assistance then is necessary from the fuel burner.

The main engine carries on its bedplate, circulating water-pumps, bilge-pumps and fuel-transfer pumps as well as the main air-compressor. In this way good fuel economy is obtained under sea-going conditions.

In port all deck winches and cargo handling machinery are furnished with steam from the donkey-boiler. The main Diesel unit

(*Continued on page* 97)

has no function to perform in port. The auxiliary air-compressor is of the high-pressure type and is capable of furnishing air both for starting and for fuel injection.

As a lumber carrier the *Frank Lynch* has proven to be very satisfactory, and should be an incentive to other operators in the lumber business to convert expensive operating steam vessels into efficient motorships at installation costs within the reach of any ship-owner.

While the power of the Diesel engine now installed in the *Frank Lynch* and the ship's speed thus obtained may be sufficient for the particular trade in which the vessel is engaged, it would be our recommendation for general cargo-carrying that from 1,250 to 1,500 s.h.p. be installed, preferably at not over 125 r.p.m. in the case of future Lake-type conversions of this tonnage. It should be possible to put this power into the existing engine-room space of 42 ft. An average sea speed of 10 to 10½ knots will result on a fuel-consumption of about 7 tons of oil per day. It would, of course, increase the first cost, but the benefit derived from the increased speed would in most cases be very great, while the slightly higher fuel-consumption of 2 tons per day would hardly make any tangible difference in the annual operating costs. While an engine speed of 135 r.p.m. will give good efficiency in a twin-screw ship of this tonnage, we are inclined to consider it a little high for a sea-going single-screw job, although this is a matter which can best be settled by naval architects or by the shipyards.

From Single-Screw Geared Turbine to Twin-Screw Diesel Drive

M. S. "Carriso," ex-S. S. "Magunkook," Is the Largest Pacific Coast Shipping Boat Yet Converted, and Is the Only Vessel Sold at Low Hull Valuation Yet Converted from Single-Screw Steam to Twin-Screw Diesel Propulsion.

WITH one exception all the Shipping Board vessel conversions have been from single-screw steam to single-screw oil-engine drive, if we do not count the *William Penn*, which was commenced as a single-screw hull and completed as a twin-screw Diesel ship. While our own observation of several hundred large motorships has left us with the impression that twin-screw propulsion offers advantages which outweigh its demerits in the case of new vessels, the problem takes on many other aspects when it comes to the matter of turning a single-screw steamer into a motorship. At present any shipyard work is expensive in this country and so it is desirable to avoid burdening a vessel with a higher overhead than is absolutely necessary for economical results. Hence, if we were in the position of ordering a new craft we probably would decide upon twin-screw for most services, but we certainly should hesitate before ordering the conversion of a single-screw steamer into a twin-screw motorship unless she was destined for a short route coastwise service. True the *William Penn* has proved a most economical, reliable and profitable ship at to-day's ship valuation, but this would have been impossible had her enormous and unwarranted wartime cost of about three-million dollars not been written down like the balance of the Board's fleet. Her Diesels bought by Ex-Chairman Hurley at the peak price, laid on the dock for two years before installation, and her hull was built at top cost. This was followed by the change-over before prices had substantially dropped. However, she is such a money-maker that the Board recently refused $600,000 for her, but are selling good operating steamers at about half that price.

"Carriso," "Ex-Magunkook a 5,621 tons d. w. Pacific Coast built freighter converted to twin-screw Diesel power.

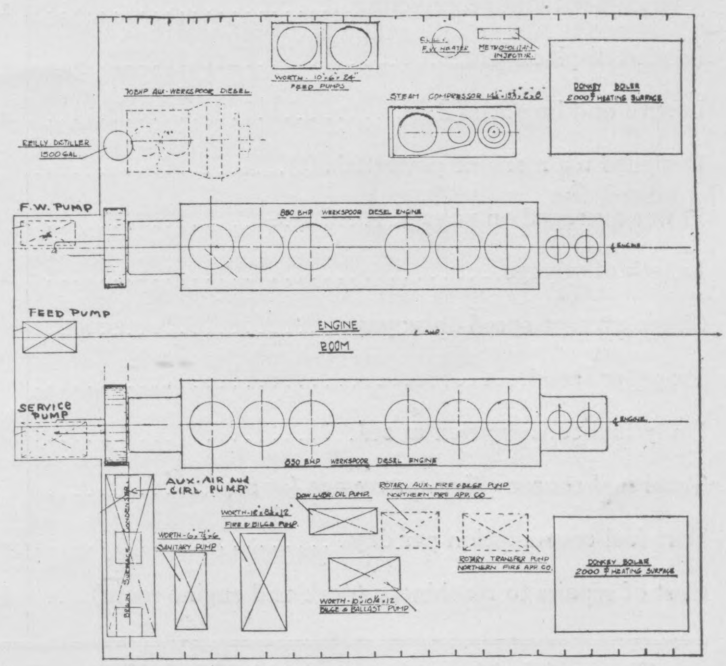
The twin-screw motorship *Carriso* ex the steamer *Magunkook*, was a single-screw Shipping Board craft built at Long Beach, Cal. in 1919, and was converted in 1923 at the Moore Shipyard, Oakland, Calif. for the Oceanic Steamship Co. of San Francisco, Calif. Twin Pacific-Werkspoor Diesels were then fitted as propelling power in place of the Curtis-type geared turbines, which were built for 2,500 s.h.p. but averaged about 2,000 s.h.p. at sea, driving a 16′ 6″ by 14′ 6″ and 87.3 sq. feet area propeller. There were three Heine boilers of 2,900 sq. ft. surface and furnishing steam to the turbine at 225 lbs., but with safety valves set at 210 lbs.

This at 85 r.p.m. drove the vessel at 10.64 knots on her trial trip over a 21.75 nautical-miles course running with a mean draft of 21′ 10½″ the propeller slip being 12.2%. These figures we give for comparison with her Diesel drive, as oil-engine power is still claimed by some to be in an experimental stage and, therefore, to be only touched with great caution; whereas it evidently was the geared-turbine in embyro condition.

The *Carriso's* dimensions now are as follows:

Loaded displacement	8,500 tons.
Light displacement	2,879 tons.
Cargo capacity of holds and 'tween decks	263,737 cu. ft. (42 cu. ft. to ton).
Normal cargo capacity, not including fuel and water	6,000 tons.
Deadweight capacity	5,621 tons.
Capacity of settling tank	55 tons.
Capacity of fuel bunkers	900 tons.
Fresh water carried	157½ tons.
Length, o. a	354′ 6″
Length, b. p	341′ 0″
Breadth, md	48′ 0″
Depth, md	27′ 3″
Mean draft, loaded	22′ 5″
Length of machinery space	45′ 10″
Engine-room and boiler staff	10 men.
Shaft horsepower	1,700 h.p.
Indicated horsepower	2,300 h.p.
Engine and propeller speed	135 r. p. m.
Ship's loaded speed	8⅓ knots.
Propeller, diameter pitch and area	10′ 6″ x 8′ 9″ x 86.5 sq. ft
Daily sea fuel-consumption including donkey boiler and auxiliaries	10¼ tons.
Total fuel burned on voyage of 7,531 miles	349 tons.
Fuel consumption per 100 miles (all purposes)	4.63 tons.
Classification	American Bureau.

Her Diesels were war-time units of Werkspoor design, built for the Shipping Board and sold by auction prior to the Board's decision to embark on a motorizing program. They were constructed under license by the Pacific Diesel Engine Co. of Oakland, Calif. There were twelve of this design and twenty-six of McIntosh &



Engine-room plan of the m. s. "Carriso" showing twin 850 s.h.p. Pacific-Werkspoor Diesel engines and steam auxiliary equipment.

Seymour construction sold at fairly low prices by the Board a couple of years ago, but at much higher prices than were then being secured for the Board's surplus steam machinery.

Steam was retained for operating the engine-room, deck auxiliary machinery, and steering gear; consequently the fuel-consumption is higher than with most motorships of her tonnage and power, although the exhaust gases from the main engines are used as far as is feasible for generating steam at sea. We understand, however, that in the near future a 70 b.h.p. Pacific-Werkspoor auxiliary oil-engine connected to a generator will be installed and current will be supplied to a number of new Northern and Jackson pumps, as the present steam operated pumps are extravagant in operation.

As much of the original equipment was retained as was possible, the results would indicate that on the whole, and compared with other ships described in this Supplement, the *Carriso* is an example of how not to carry out a conversion rather than an ideal job, her excellent Diesel engines being surrounded by a lot of unsuitable and consequently uneconomical equipment. Under the circumstances nothing beneficial can be gained by reproducing the list of her auxiliary steam equipment which we have before us. The auxiliary air-compressor installed when the conversion was carried out was in tandem $14\frac{1}{4}'' \times 13\frac{7}{8}'' \times 2 \times 8$ Pacific unit, driven by a compound steam-engine built by Sir W. G. Armstrong Whitworth, Newcastle-on-Tyne, England. Was not the Diesel unit complete in itself and carried on its bedplate, circulating-water, bilge, fuel-transfer, and lubricating-oil pumps as well as the main air-compressor the economy of the vessel probably would not be so good as it is.

No gain was accomplished in cubic-cargo capacity. As a matter of fact the double shaft-alley required for the new twin-screw drive absorbed considerable space in comparison with the single shaft-alley of the steam ship. It was found necessary to alter accommodations somewhat and add cargo space above to compensate for the loss in hold cubic capacity.

The changes to the hull involved new engine seatings, removal of fire-room bulkhead and reinforcing this bulkhead frame above; the shifting of one shaft alley and the installation of one new shaft alley; alterations to the stern frame, and the installation of two stern tubes, strutts and etc., as well as installation of donkey boilers and new uptakes; also a change in the stack location.

Log of *M. S. Carriso* on first trip after conversion to Diesel power.

	San Francisco to Manila	*San Francisco to Manila and return*
Steaming time	33 days, 21 hrs., 45 mins.	67 days, 21 hrs., 10 mins.
Passage	43 days, 10 hrs., 40 mins.	90 days, 10 hrs., 45 mins.
Distance by observation	7,531.5 miles	13,811.3 miles.
Distance by wheel	9,002.8 miles.	17,760.5 miles.
Slip of propeller	16.343 per cent.	22.276 per cent.
Ship's speed	9.25 knots.	8.478 knots.
Engine speed	128.12 r. p. m.	128.12 r. p. m.
Fuel-oil consumed	2,443 bbls.	5,043 bbls.
Fuel oil per 24 hours	71.79 bbls. ($10\frac{1}{3}$ tons)	74.303 bbls. (both figures include donkey-boiler going for auxiliaries.)
Consumption per 100 miles	32.437 bbls.	36.515 bbls.
Fresh water consumed	148.5 tons	283.5 tons.
Sea detention	8 hrs., 23 mins.	18 hrs., 16 mins.
Total detention	9 hrs., 12 mins., 55 seconds.	22 hrs., 13 mins., 35 seconds

Oil consumed in port using two donkey boilers for cargo winches:

At Cebu	98
Yloilo	99
Tabac	57
Manila	509
Total	763 bbls.
Oil received at San Francisco	5,806 bbls.
Oil consumed	5,806 bbls.
Port movements	34 miles.

The *Carriso* has very full lines aft, which always have been a hindrance to speed.

Does It Pay to Convert 12,000-Ton Shipping Board Vessels?

Round-the-World Operating Comparisons Between Hulls with Three Different Types of Steam Machinery, and with a Hull Commenced as a Steamer but Finished as a Diesel-driven Motorship.

(Checked by U. S. Shipping Board)

PARTICULARS	**S. S. Ethan Allen** (Quad. Exp. Steam)	**S. S. Eclipse** (Geared Turbine with Superheated Steam)	**S. S. Eclipse** (Turbo-Electric with Superheated Steam)	**M. S. William Penn** (Diesel-drive 4-cycle Diesel)
Deadweight capacity	12,635 tons	11,773 tons	11,721 tons	12,375 tons
Net general-cargo capacity under-deck one 10,000 miles voyage without rebunkering	11,080 tons	10,200 tons	10,150 tons	11,725 tons
Loaded displacement	17,008 tons	15,946 tons	15,946 tons	17,100 tons
Length and breadth (B. P.)	$439\frac{1}{2}' \times 60'$	$440' \times 56'$	$440' \times 56'$	$439\frac{1}{2}' \times 60'$
Designed main engine power (shaft)	3,000	3,000	3,000	3,500
Power averaged on voyage	2,715 i.h.p.	2,422 s.h.p.	2,333 s.h.p.	3,600 s.h.p. (4,228 i.h.p.)
Length of voyage	22,951 miles	23,611 miles	27,931 miles	28,317 miles
Ship's average speed on voyage	10.78 knots	9.68 knots	10.15 knots	11.29 knots
Propeller speed	68.7	No record	92.5 r.p.m.	112 r.p.m.
Daily fuel-consumption at sea	37.47 tons	30 tons	31.7 tons	$14\frac{1}{2}$ tons
Total fuel-consumption on voyage (at sea)	3,220 tons	3,025 tons	3,613 tons	1,395 tons
Port fuel-consumption per day	7.6 tons	No record available	5.98 tons	0.64 tons
Cost of repairs to machinery (deck and engine-room)	$3,501	No record available	$3,396	$112

The total fuel burned at sea by the **M. S. William Penn** on three voyages aggregating 83,063 miles at 11.06 knots average speed was $4{,}106\frac{1}{2}$ tons, or about the same as a steamer one knot slower on one voyage. Total engine-room and deck machinery repairs amounted to $243.

Why I Urged Passage of the Ship Conversion Act

Recognition of the Diesel Type of Engine Has at Last Been Officially Given. Between Ships Equipped by the Shipping Board and New Constructions Ordered by Private Operators, the United States Will Have Within a Few Years the Largest and Most Up-to-date Fleet of Motorships in the World, and Will Have a Chance of Winning Our Fair Share of the Carrying Trade for the American Flag.

WRITTEN SPECIALLY FOR MOTORSHIP BY REPRESENTATIVE GEO. W. EDMONDS, Pa.

TO-DAY in the ports of the world ships without funnels are creating as much interest as ships without sails created within the memory of many now living.

Demand for economies in ship operation has caused builders of ships to investigate all the many theories advanced that in any way presented a plausible chance of reducing operating expenses so that the costs would be reduced, and the trade exchange between countries stimulated.

> No Congressman fought harder than George W. Edmonds of Pennsylvania to amend the Merchant Marine Act of 1920 so as to enable the Loan Fund to be used for converting our out-of-date and inefficient steamers to modern economical oil-engine power. For several years Representative Edmonds carried on a vigorous campaign both in Congress and in the daily press which resulted in the bill passing the House last June, whence it was ably guided through the Senate by Senator Wesley L. Jones of Washington, sponsor of the original Act.—*The Editor.*

Many of these proposed changes have been of little value, but within the last quarter of a century the motorizing of ships has been thoroughly tested and has proven so successful that to-day no ship, large or small, should be constructed without a thorough investigation of the possibility of this type of propulsion being the most efficient and most economical.

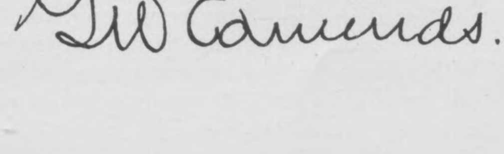
Before the great war in Europe quite a number of ships were equipped with Diesel engines. It is presumed that many changes in engine structure had to be made, as is usual in new ideas, and many prejudices overcome, but with evident success. In August 1915 in Dairen, China, I was an interested visitor upon the Danish cargo-ship *"Falstria"* driven by Diesel engines. The ship had made the entire trip from Denmark to China without any trouble whatever, notwithstanding she did not have a trial trip before this voyage as the war activities prevented any short run after construction.

The engineers had opened the cylinders to look them over as a precautionary measure, and I spent the whole day with the chief looking with wonder and interest upon what to me at first seemed an enlarged automobile engine burning fuel-oil instead of gasolene. When shown the economies of space, the ease of handling the engines, the comparatively low cost of fuel, the savings in upkeep not only in the engine-room but on deck, I left the ship convinced that even should there be no improvement in these engines, I had been looking at what must be the future motive power of ships.

Since then I have not hesitated in Congress or elsewhere in recommending their installation. Had I been allowed my way after the war was over and the armistice declared, I would have completed all the ships under construction and of a practical commercial size with internal-combustion engines. I did try to have this done, but was not successful.

However, with the passage of the Ship Conversion Bill last June, recognition of this type of engine has at last been officially given, and with the very exhaustive studies made by Admiral W. S. Benson and his experts I have no doubt that between those ships equipped by the Shipping Board, and the new construction ordered by private operators, the United States will have within a few years the largest and most up-to-date fleet of motorships in the world. And with these craft our shipowners should be able to nearly approximate the operating costs of the ships of other nations, placing our ships in competition with a chance of winning our fair share of the carrying trade for the American flag.

It is my prediction that the practicability of the motorship will more and more be recognized in new construction, both passenger and freight, and that before many years the steam-driven vessel will be as much a thing of the past as the sailing vessel is to-day.



Electrical Auxiliary Machinery on Shipboard

This article, Written by J. Lyell Wilson of the Technical Staff of the American Bureau of Shipping, is Reproduced from the Bureau's Bulletin of September-October, 1924. It Deals in a Comprehensive Manner with the Economics of Electrical Auxiliaries Aboard Steamers Converted to Motorships.

THE application of electrical power for operating the auxiliary machinery on board ship constitutes one of the most interesting problems in marine engineering today, and the reason for its being thrust to the fore is undoubtedly the astounding growth of the motorship fleet. The desire to eliminate the steam boiler on the motorship gave the electrical engineers an opportunity to demonstrate the reliability and relative economy accruing from the complete electrification of engine-room and deck auxiliaries.

This, of course, does not mean that the use of electric auxiliaries is confined to the motorship or to the Diesel-electric driven ship, nor is it improbable that the benefits derived from their use on such vessels will also be apparent if applied to the ordinary steam vessel, with the possible exception of large steam-driven passenger vessels.

In order, therefore, to analyze the economies involved by the use of electric auxiliaries in the various types of vessels, the following figures were obtained from the General Electric Company:

The log of a motorship for a voyage covering 19,600 miles, carrying general cargo and calling at eleven ports, shows that she spent 69 days at sea and 53 days in port. All auxiliary machinery is electric driven and the fuel consumption at sea for one auxiliary engine with a load of 50 to 60 kw. was about 100 gallons or two barrels per day. The fuel in port averaged 4.1 barrels per day for all purposes. This is comparable with 53 barrels on a similar all-steam installation.

The sea fuel consumption of the motorship of two barrels per day may be compared to that of a motorship with steam auxiliaries requiring about 20 barrels per day. The available data on such ships is very meagre, but this figure is given as a fair average.

The costs of auxiliary machinery vary with the quality of equipment selected and also with the requirements of different Diesel engine builders. For a new motorship of about 7,500 to 10,000 tons deadweight it is estimated that electric auxiliaries will cost approximately $125,000, as compared with about $70,000 for steam equipment.

There would, of course, be a difference of about 45 tons in the machinery weights in favor of electric auxiliaries, to which should be added 25 tons of fresh water for a make-up feed for the boiler.

On this basis the comparison is as follows:

Motorship with Electric Auxiliaries vs. Motorship with Steam Auxiliaries

(Fuel oil 20° B. at $1.70 bbl.)

Auxiliaries Only	*Electric*	*Steam*
15% depreciation on $125,000	$18,750	......
20% depreciation on $70,000	......	$14,000
Port fuel 150 days at 4.1 bbls. day	1,050	......
Port fuel 150 days at 53 bbls day	......	13,500
Sea fuel 200 days at 2 bbls. day	680	......
Sea fuel 200 days at 20 bbls. day	......	6,800
	$20,480	$34,300

This shows a difference of $13,820 per year in favor of the electric auxiliaries, which is about 25 per cent return on the difference in cost between the steam and electric. Briefly stated therefore it appears that the added cost of the electric auxiliaries would be completely wiped out in less than four years.

Similarly, in comparing a steam vessel with steam auxiliaries and one with electric auxiliaries, if all auxiliaries on such a vessel except the feed and condensing system were electrically driven and obtained power from the turbine generators, the fuel requirements for auxiliary purposes would be approximately 25 barrels per day at sea and 30 barrels per day in port.

The most interesting problem today, however, is in converting existing steamers to Diesel engine propulsion, for in such cases there is a natural desire to retain existing steam auxiliaries especially when the survey shows them to be in good condition. The cost of new electric auxiliaries would be about the same as given for the motorship. On the other hand, if steam auxiliaries are retained it would be necessary to overhaul and rearrange them and add such equipment as an auxiliary air compressor, etc., so that the additional cost of complete electrification of auxiliaries would amount to about $100,000:

Converted Steamer with Old Auxiliaries Retained vs. Complete Auxiliary Electrification

(Fuel oil 20° B. at $1.70 bbl.)

	Electric	*Steam*
15% depreciation on $100,000	$15,000	......
Port fuel 150 days at 4.1 bbls. day	1,045	......
Port fuel 150 days at 53 bbls. day	......	$13,500
Sea fuel 200 days at 2 bbls. day	680	......
Sea fuel 200 days at 20 bbls. day	......	6,800
	$16,725	$20,300

This indicates a saving of only $3,600 per year, mainly because the steam auxiliaries have been allowed full depreciation. The item of maintenance should therefore be given considerable weight in this case, since the upkeep on a boiler with its feed and fuel system, steam pumps, steam deck machinery and condenser with all the engine room and deck piping, will probably be very much greater than that of the electric system. As an illustration of this, the maintenance in 18 months on the motorships *California* and *Missourian* was reported to be less than $1,000 per ship, or at the rate of about $640 per ship per year.

It has been suggested that in converting existing steamers to motorships a compromise might be effected which would give the lowest possible first cost and at the same time obtain the advantage of electrical auxiliaries at sea. Such a proposal includes the retention of one of the ship's boilers result in a ship requiring almost as much fuel in port as she and all the steam-driven machinery for port use, including the windlass. With this arrangement the boiler fires could be extinguished on leaving port and not started until approaching the next port. The fuel consumption at sea would then be as good as that of an ordinary motorship and in port the same as an ordinary steamer. The difference in cost between such partial and complete electrification is estimated at about $70,000. This method of operation, however, would would require for all purposes at sea. It therefore appears economically unsound to invest approximately half a million dollars to install Diesel engines and forego practically 50 per cent of the benefits to be derived from conversion for the sake of saving about $70,000.

Such academic studies of the expected relative economies under various conditions serve a useful basis for discussion but, from an engineering viewpoint the most convincing facts are those derived from the performance of two vessels as nearly equal in all characteristics as possible.